2013-09

Compilation of Abstracts, September 2013

Monterey, California; Naval Postgraduate School

NPS-04-13-004

COMPILATION OF

ABSTRACTS

Unrestricted Dissertations, Theses, and Final Projects

NPS Class of September 2013

Office of the Vice President and Dean of Research
NAVAL POSTGRADUATE SCHOOL
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PREFACE

This publication, Compilation of Abstracts, contains abstracts of unrestricted dissertations, theses, and capstone project reports submitted for the doctor of philosophy, master of arts, master of business administration, and master of science degrees for the Naval Postgraduate School's September 2013 graduating class. A digital copy of this publication can be found at https://calhoun.nps.edu/handle/10945/60867 while the corresponding metadata can be found at https://calhoun.nps.edu/handle/10945/37775.

This compilation is published to acquaint those interested in the fields represented with the nature and substance of Naval Postgraduate School student research, which covers a wide range of defense-related topics. An online copy of this and previous editions can be found at https://calhoun.nps.edu/handle/10945/27474. Calhoun, the institutional archive of NPS, provides a convenient way to search the content of unrestricted theses. Search for specific full-text theses and dissertations by author, advisor, branch of service, date issued, degree, department, or type at https://calhoun.nps.edu/handle/10945/17.

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For other inquiries about student and faculty research at NPS, please contact the Dean of Research, Jeffrey Paduan:

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For details on degree programs at NPS, please contact the director of admissions at (831) 656-3093 or grad-ed@nps.edu. The NPS admissions website is at https://www.nps.edu/web/admissions and the academic catalog is available online at https://www.nps.edu/web/registrar/academic-catalog.

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INTRODUCTION

DOCTOR OF PHILOSOPHY

MASTER OF ARTS IN SECURITY STUDIES

MASTER OF BUSINESS ADMINISTRATION

MASTER OF SCIENCE

Master of Science in Applied Cyber Operations

Master of Science in Applied Mathematics

INTRODUCTION

The Naval Postgraduate School is pleased to present the dissertation, thesis, and capstone project report abstracts for unrestricted research completed in September 2013 by the graduating class.

MISSION

The Naval Postgraduate School (NPS) was established to serve the advanced educational needs of the Navy. The broad responsibility of NPS is reflected in its stated mission:

To increase the combat effectiveness of commissioned officers of the naval service to enhance the security of the United States. In support of the foregoing and to sustain academic excellence, NPS fosters and encourages a program of relevant and meritorious research which supports the needs of the Navy and the Department of Defense (DOD) while building the intellectual capital of NPS faculty.

To fulfill its mission, the Naval Postgraduate School advances innovation in the Navy and prepares officers for employing new technologies. The research program at NPS supports the mission of graduate education. Research at NPS

- advances knowledge in a wide range of disciplines relevant to the Navy/DOD;
- maintains upper-division course content and cutting-edge programs;
- provides the opportunity for students to demonstrate independent graduate-level scholarship in their areas of study;
- challenges students with creative problem-solving experiences on DOD-relevant issues;
- solves warfare problems; and
- attracts and retains quality faculty with state-of-the-art expertise.

To meet its educational requirements, the Navy has developed a unique academic institution at NPS and via distance learning (DL) through specially tailored academic programs and a distinctive educational experience tying academic disciplines to naval and joint warfighting applications. NPS has aligned its education and research programs to achieve three major goals:

1. nationally recognized academic programs that support the operations of the Navy and Marine Corps, our sister services, and our allies;
2. research programs that focus on the integration of education and research in support of current and emerging national security technologies and operations; and
3. executive and continuing education programs that support sustained intellectual innovation and growth throughout an officer's career.

ACADEMIC PROGRAMS

School of International Graduate Studies (SIGS)

The unique programs and faculty expertise within SIGS seek to identify and address current and emerging security challenges and strengthen multilateral and bilateral defense cooperation between the United States and other nations. Areas of expertise range from nuclear nonproliferation to counterterrorism; from the history of war to emerging biological and cyber threats; and from the security aspects of political economy to international law.

- Civil-Military Relations
- Combating Terrorism Strategy and Policy
- Defense Decision Making and Planning
- Homeland Security and Defense
- Security Studies
- Stabilization and Reconstruction
- National Security and Intelligence,
  Regional Studies:
  - Middle East, South Asia, Africa
  - Far East, Southeast Asia, the Pacific
  - Europe and Eurasia
  - Western Hemisphere

Graduate School of Business and Public Policy (GSBPP)

GSBPP reflects the management side of national defense in support of operational requirements, with programs open to the U.S. uniformed services, DOD employees and contractors, federal employees, and international military and government employees. An integrated civilian and military faculty focuses on defense organizations, system applications, and instruction supported by extensive defense-oriented research.

- Acquisition and Contract Management
- Advanced Acquisition Program
- Contract Management (DL)
- Defense Business Management
- Defense Systems Analysis
- Defense Systems Management
- Executive MBA (DL)
- Financial Management
- Information Systems Management
- Material Logistics Support
- Manpower Systems Analysis
- Program Management (DL)
- Supply-Chain Management
- Systems Acquisition Management
- Transportation Management

Graduate School of Engineering and Applied Sciences (GSEAS)

GSEAS provides advanced education in engineering and applied sciences while developing technological advances with strict application to DOD needs, thus setting it apart from civilian graduate schools of engineering. It is focused on preparing the next generation of U.S. and international leaders, military and civilian alike, for the uncertainties and challenges of a rapidly changing technological world.

- Applied Mathematics
- Combat Systems Sciences and Technology
- Electronic Systems Engineering (residential and DL)
- Mechanical Engineering for Nuclear-trained Officers (DL)
- Meteorology and Oceanography
- Meteorology
- Naval/Mechanical Engineering
- Oceanography
- Operational Oceanography
- Reactors–Mechanical/Electrical Engineering (DL)
- Space Systems Engineering
- Space Systems Operations (residential and DL)
- Systems Engineering (residential and DL)
- Systems Engineering Management (DL)
- Undersea Warfare
- Underwater Acoustic Systems (DL)

Graduate School of Operational and Information Sciences (GSOIS)

GSOIS delivers graduate-level education and conducts cutting-edge research in four non-traditional knowledge domains responsive to U.S. military needs: information science and technology, military computer science, military operations analysis and research, and special operations and related defense analysis.

- Applied Cyber Operations
- Computer Science (residential and DL)
- Computing Technology (DL)
- Cyber Systems and Operations
- Cost Estimating and Analysis (DL)
- Electronic Warfare Systems (international)
- Human Systems Integration
- Identity Management and Cyber Security (residential and DL)
- Information Sciences
- Information Systems and Operations
- Information Systems and Technology
- Information Warfare
- Joint C4I Systems
- Joint Information Operations
- Joint Operational Logistics
- Modeling, Virtual Environments, and Simulation
- Operations Analysis
- Remote Sensing
- Software Engineering (residential and DL)
- Special Operations
- Systems Analysis (DL)

Office of the Provost

The Office of the Provost provides oversight to a specialized degree program that leads to a master of science in systems engineering analysis. Students benefit from cross-disciplinary course offerings and research opportunities found in GSEAS systems engineering and GSOIS systems and operational analysis curricula.

- Systems Engineering Analysis

STUDENT POPULATION

The student body consists of U.S. officers from all branches of the uniformed services, civilian employees of the federal government, and international military officers and government civilians. The student population distribution for September 2013 is shown in Figure 1.

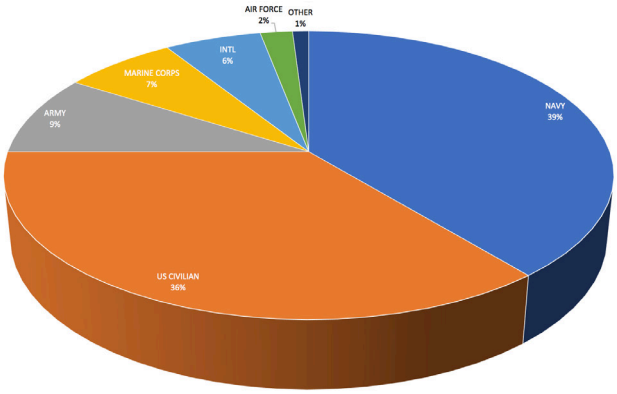


Figure 1: Total enrollment by student type for the fourth quarter of 2013. Source: NPS Academic Affairs Quarterly Enrollment Report, AY2013/Quarter 4.

STUDENT RESEARCH

Independent scholarly work in the form of a dissertation (PhD), thesis (master's/engineer), or capstone project is required for most academic programs. Student research projects address issues ranging from the current needs of the fleet and joint forces to the science and technology required to sustain long-term superiority of the Navy and DOD. Guided by faculty advisors, NPS students represent a vital resource within the DOD for addressing warfighting problems and maintaining cutting-edge expertise, particularly in a time when technology and information operations are changing rapidly. Naval Postgraduate School alumni think innovatively and possess the knowledge and skills to apply nascent technologies in the commercial and military sectors. Their firsthand grasp of operations, when combined with challenging projects that require them to apply their focused graduate coursework, is one of the most effective elements in solving fleet, joint-force, and regional problems. NPS graduate education encourages a lifelong capacity for applying basic principles and creative solutions to complex problems. NPS is also unique in its ability to conduct classified research. Classified theses are available on the NPS SIPRNet.

Source: Naval Postgraduate School Public Affairs Office

DEGREES OFFERED

Curricula meet defense requirements within the traditional degree framework through residential or distance-learning programs. The curricula listed below lead to master's, engineer, or doctor of philosophy degrees. NPS also offers certificate and executive education programs, which do not require theses.

Doctor of Philosophy
- Applied Mathematics
- Applied Physics
- Astronautical Engineering
- Computer Science
- Electrical Engineering
- Engineering Acoustics
- Information Sciences
- Mechanical Engineering
- Meteorology
- Modeling, Virtual Environments, and Simulation
- Operations Research
- Physical Oceanography
- Security Studies
- Software Engineering
- Systems Engineering

Engineer
- Astronautical
- Electrical
- Mechanical

Master of Arts
- Identity Management and Cyber Security
- Security Studies

Master of Business Administration
- Master of Business Administration
- Executive Master of Business Administration

Master of Computing Technology

Master of Cost Estimating and Analysis

Master of Engineering
- Computer Engineering
- Electrical Engineering

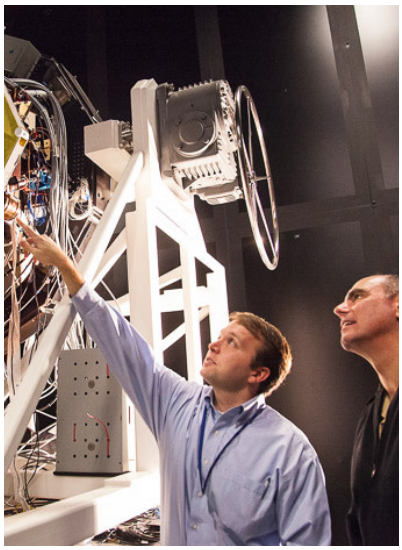
Master of Engineering Acoustics

Master of Human Systems Integration

Master of Science
- Applied Cyber Operations
- Applied Mathematics
- Applied Physics
- Applied Science
- Astronautical Engineering
- Combat Systems Technology
- Computer Science
- Contract Management
- Cyber Systems and Operations
- Defense Analysis
- Electrical Engineering
- Electronic Warfare Systems Engineering
- Engineering Acoustics
- Engineering Science
- Engineering Systems
- Human Systems Integration
- Information Strategy and Political Warfare
- Information Technology Management
- Information Warfare Systems Engineering
- Management
- Mechanical Engineering
- Meteorology
- Meteorology and Physical Oceanography
- Modeling, Virtual Environments, and Simulation
- Network Operations and Technology
- Operations Research
- Physical Oceanography
- Physics
- Product Development
- Program Management
- Remote Sensing Intelligence
- Software Engineering
- Space Systems Operations
- Systems Engineering
- Systems Engineering Analysis
- Systems Engineering Management
- Systems Technology

Master of Systems Analysis

Source: NPS Public Affairs Office



Source: NPS Public Affairs Office

SEPTEMBER 2013 DEGREES CONFERRED

The September 2013 graduating class produced 180 unrestricted dissertations, theses, and capstone project reports as part of the graduation requirement. Figure 2 indicates the distribution of degrees awarded by academic school.

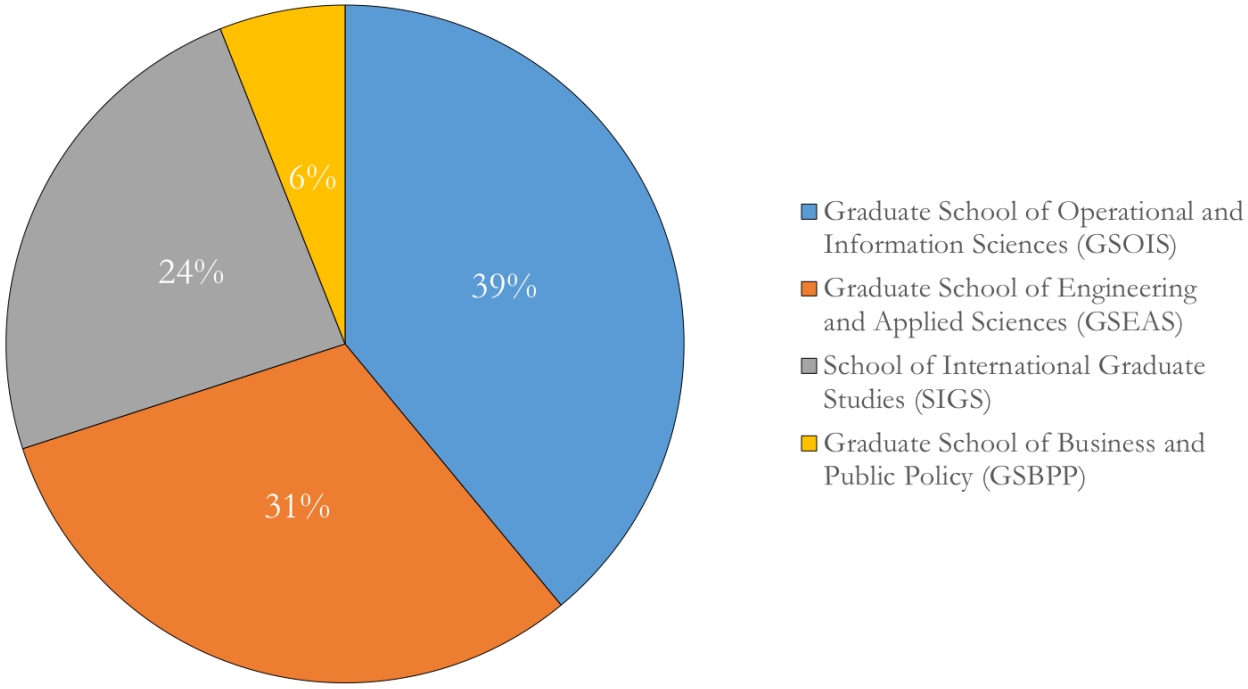
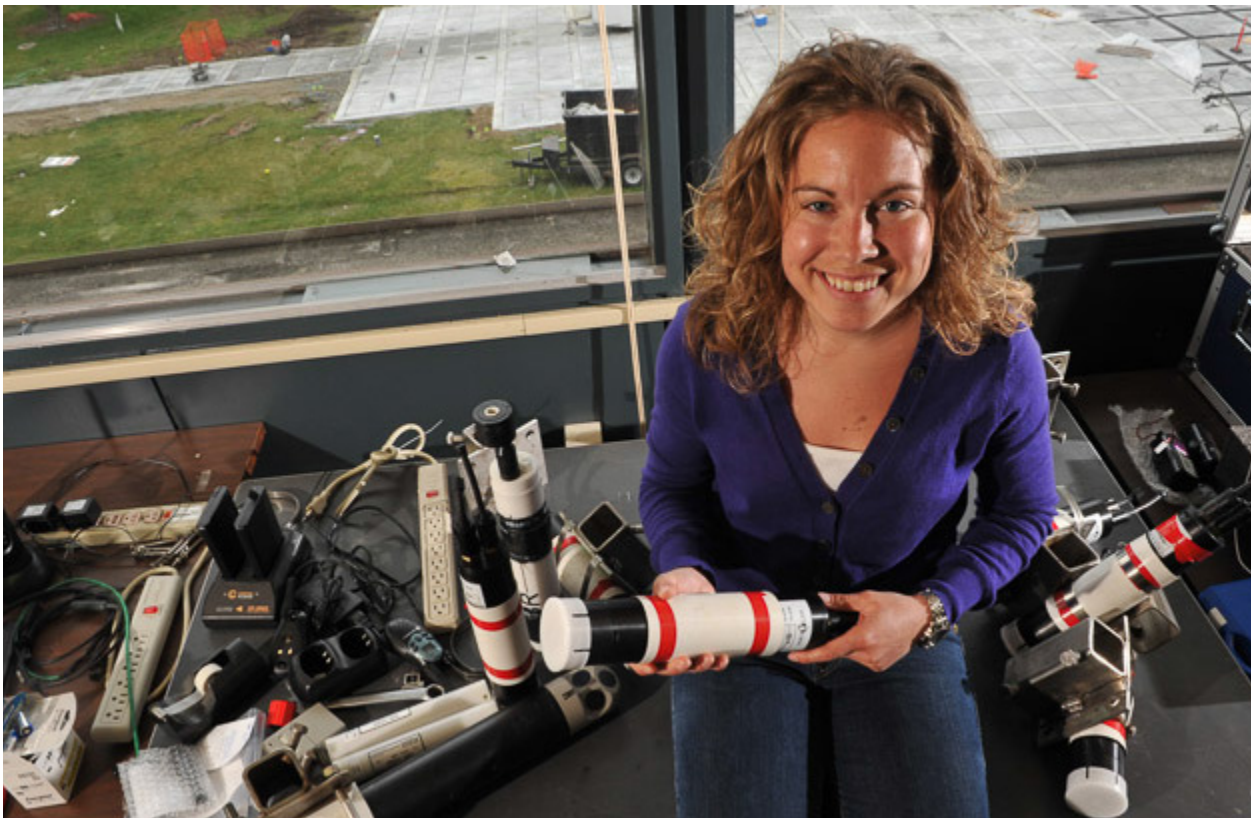


Figure 2. Distribution of degrees conferred by academic school, September 2013 (unrestricted theses)



Source: NPS Public Affairs Office

ACADEMIC AWARDS ANNOUNCED SEPTEMBER 2013

Many departments honor graduating students for the quality and contributions made by their dissertations, theses, or capstone reports. The following listing recognizes students selected by NPS faculty and military associations for superior academic achievement and outstanding theses.

Campus-Wide

- Monterey Council Navy League Award for Highest Academic Achievement: Lieutenant Commander Duncan Robert Ellis, U.S. Navy—Outstanding Thesis: *Algorithms for Efficient Intelligence Collection*
- Naval Postgraduate School Outstanding Academic Achievement Award for International Students: Mr. Hsu Ann Daryl Lee, ST Electronics (Info-Software Systems) Pte Ltd., Singapore—Outstanding Thesis: *Toward Large-Graph Comparison Measures to Understand Internet Topology Dynamics*; and Major Tobias Treml, German Army—Outstanding Thesis: *A Revolutionary Approach for the Development of Future Ground Combat System Specifications*
- Naval Postgraduate School Outstanding Academic Achievement Award for Department of Defense Student: Ms. Virginia Babcock, Department of the Army
- The Hans Jones Award for Excellence in Thesis Research in Special Operations and Irregular Warfare or Security, Stabilization, Transition and Reconstruction: Lieutenant Commander Scott K. Timmester, U.S. Navy
- Association of the United States Army, General Joseph W. Stilwell Chapter, Award for Outstanding Army Student: Captain Fritz J. Schultes, U.S. Army
- The Surface Navy Association's Award for Excellence in Surface Warfare Research: Commander William J. Bard, U.S. Navy
- Monterey Kiwanis Club Outstanding International Student Award: Lieutenant Frode Mjelde, Norwegian Navy—Outstanding Thesis: *Performance Assessment of Military Teams in Simulator and Live Exercises*
- Chief of Naval Operations Undersea Warfare Award: Ensign Daniel Watts, U.S. Navy
- The Philip Zimbardo Award: Mr. Judson J. Dengler, U.S. Secret Service

Graduate School of Business and Public Policy (GSBPP)

- The Louis D. Liskin Award for Excellence in Business and Public Policy: Ms. Virginia Babcock, Department of the Army; Mr. Derrick Torgerson, Department of the Army; and Lieutenant Dean Fanner, U.S. Navy

Graduate School of Engineering and Applied Sciences (GSEAS)

- John McReynolds Wozencraft Electrical and Computer Engineering Academic Honor Award: Mr. Chia Sem Wong, Defence Science and Technology Agency, Singapore
- Space Systems Operations Award for Academic Excellence: Captain Fritz J. Schultes, U.S. Army; and Captain Miguel Alvarez, USMC
- Admiral William Adger Moffett Space Systems Award: Major Brian Slosman, U.S. Army
- Space and Naval Warfare Systems Command Award in Electronic Systems Engineering: Lieutenant Commander Zachariah Stiles, U.S. Navy
- Naval Sea Systems Command Award in Naval/Mechanical Engineering: Lieutenant Samuel Fromille IV, U.S. Navy
- Submarine Force Undersea Warfare Curriculum Award: Lieutenant Andrew Streenan, U.S. Navy; and Lieutenant Joshua Weiss, U.S. Navy
- Meyer Award for Outstanding Student in Systems Engineering (Distance Learning): Matthew Koch, John Pomfret, Meredith Almoney, Bryan Otis, Lauren White, Paul Walter, and Dustin Jepperson

Graduate School of Operations and Information Sciences (GSOIS)

- Chief of Naval Operations Award for Excellence in Operations Research: Lieutenant Commander Duncan Robert Ellis, U.S. Navy
- The Gary Kildall Award for Computing Innovation: Major James Reynolds, USMC; and Mr. Michael McCarrin, Department of the Navy
- Commander George L. Phillips Modeling, Virtual Environments, and Simulation Award: Major James

Reynolds, USMC— Outstanding Thesis: *Virtual Environment Training on Mobile Devices* (co-author listed in the abstract)
- Military Operations Research Society Stephen A. Tisdale Graduate Research Award: Lieutenant Commander Ryan McLaughlin, U.S. Navy— Outstanding Thesis: *Optimizing Adversary Training and the Structure of the Navy Adversary Fleet*
- Chief of Naval Operations Information Warfare Award: Lieutenant Commander Raymond Max Guethler IV, U.S. Navy—Outstanding Thesis: *Optimization of Passive Coherent Receiver System Placement*
- Rear Admiral Grace Murray Hopper Information Technology Management Award: Captain James Mastrom, USMC
- Rear Admiral Grace Murray Hopper Computer Science Award: Lieutenant Commander Jeremy Martin, U.S. Navy

School of International Graduate Studies (SIGS)
- The Louis D. Liskin Award for Excellence in Regional Security Studies: Captain Sasha J. Kuhlow, USMC
- The International Student Award for Excellence in Regional or Security Studies: Captain Huseyin Yigit, Turkish Army
- The Outstanding United States Air Force Graduate Award, Department of National Security Affairs: Major Paul R. Pawluk, U.S. Air Force
- The Curtis H. "Butch" Straub Achievement Award: Mr. Daniel W. O'Connor, U.S. Department of Homeland Security

Outstanding Thesis Recognition
- Lieutenant Commander Eid S. Alqhatani, Royal Saudi Naval Forces; and Lieutenant Commander Fahad A. Bin Huwaymil, Royal Saudi Naval Forces: *Analysis, Design and Implementation of a Proof-of-Concept Prototype to Support Large-Scale Military Experimentation*
- Mr. Daniel T. Cain, Senior Industrial Hygienist, Oregon Health Authority, Portland, Oregon: *Twituational Awareness: Gaining Situational Awareness via Crowdsourced #disaster Epidemiology*
- Major Steven R. Crews II, U.S. Army: *Increasing Slew Performance of Reaction Wheel Attitude Control Systems*
- Lieutenant Commander Georgios Dimitriou, Hellenic Navy: *Integrating Unmanned Aerial Vehicles into Surveillance Systems in Complex Maritime Environments*
- Major Ola Larsson, Swedish Army: *Pseudorandom Number Generators for Mobile Devices: An Examination and Attempt to Improve Randomness*
- Lieutenant Commander Erik LaSalle, U.S. Coast Guard: *One Size Does Not Fit All: A System Development Perspective*
- Commander, Samuel I. Marshall, U.S. Navy: *Modtran Radiance Modeling of Multi-Angle Worldview-2 Imagery*
- Lieutenant Jason Moody, U.S. Navy: *Crisis in Honduras: The Search for Answers to the Removal of President Manuel Zelaya*
- Major James V. Reynolds, USMC; and Major Craig L. Smith, USMC: *Virtual Environment Training on Mobile Devices*
- Captain Matthew S. Weant, USMC: *Fingerprinting Reverse Proxies Using Timing Analysis of TCP Flows*
- Lieutenant Jeffrey Wilcox, U.S. Navy: *Content-Aware Adaptive Compression of Satellite Imagery Using Artificial Vision*

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DOCTOR OF PHILOSOPHY

AFFINE EQUIVALENCE AND CONSTRUCTIONS OF CRYPTOGRAPHICALLY STRONG BOOLEAN FUNCTIONS

Jong Ho Chung–Major, United States Army
Doctor of Philosophy in Applied Mathematics
Advisor: Pantelimon Stanica, Department of Applied Mathematics

In this thesis, we study a type of affine equivalence for the monomial rotation-symmetric (MRS) Boolean functions and two new construction techniques for cryptographic Boolean functions based on the affine equivalence of cryptographically strong base functions and fast Boolean operations. Affine equivalence of cryptographic Boolean functions presents a formidable challenge to researchers due to its complexity and the size of the search space. We focus on an affine equivalence based on permutation of variables for MRS Boolean functions and their relationship to circulant matrices over the binary field F2 and regular graphs. We first establish a relationship between generalized inverses of circulant matrices in F2 and their generating polynomials. We then apply the relationship to gain insight into necessary conditions for the affine equivalence, based on permutations of variables for MRS Boolean functions. We also propose a theoretical connection between regular graphs and MRS Boolean functions to further our study in affine equivalence. Finally, we present two constructions for Boolean functions with good cryptographic properties. The constructions take advantage of two affine-equivalent base functions with strong cryptographic properties. We analyze the cryptographic properties of the constructions and demonstrate an application with these base functions, called the hidden weighted-bit functions. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37602

Keywords: Boolean function, cryptography, affineequivalence

ENHANCING MICROBOLOMETER PERFORMANCE AT TERAHERTZ FREQUENCIES WITH METAMATERIAL ABSORBERS

Brian Kearney–Civilian, Department of the Navy
Doctor of Philosophy in Applied Physics
Advisor: Gamani Karunasiri, Department of Physics

For Terahertz (THz) imaging to be useful outside of a laboratory setting, inexpensive yet sensitive detectors such as uncooled microbolometers will be required. Metamaterials can improve THz absorption without significantly increasing the thermal mass or using exotic materials because their absorption is primarily dependent on the geometry of the materials and not their individual optical properties. Finite Element (FE) simulations revealed that an array of squares above a ground plane separated by a dielectric is efficient, yet thin. Metamaterials were fabricated, and their absorption characteristics were measured using a Fourier Transform Infrared Spectrometer (FTIR), indicating that the FE simulations are accurate. Metamaterial structures tuned to a quantum cascade laser (QCL) illuminator were incorporated into a bi-material sensor, which was used for detection of THz radiation from the QCL source with good sensitivity. In the case of microbolometers, a bolometric layer needs to be embedded in the metamaterial to form a thin microbridge. Simulations indicated that, if the bolometric layer was resistive enough or close enough to the ground plane, absorption would be largely unaltered. Metamaterials with a conductive Titanium (Ti) layer

embedded into the dielectric spacer were fabricated and measured with an FTIR, confirming this behavior. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37647

Keywords: terahertz, etamaterial, perfect absorber, microbolometer, thermal imager, bimaterial sensor, thin film absorber

PROCESSING, MICROSTRUCTURE, AND MATERIAL PROPERTY RELATIONSHIPS FOLLOWING FRICTION STIR WELDING OF OXIDE DISPERSION STRENGTHENED STEELS

Bradford Baker–Commander, United States Navy
Doctor of Philosophy in Mechanical Engineering
Advisor: Luke Brewer, Department of Mechanical and Aerospace Engineering

A comprehensive set of processing, microstructure, and material property relationships is presented for friction stir welded oxide dispersion strengthened MA956 steel. Eight rotational and traverse speed combinations were used to produce friction stir welds on MA956 plates using a polycrystalline cubic boron nitride tool. Weld parameters with high thermal input produced defect-free, full penetration welds. Microstructural analysis showed a significant increase in grain size, a persistent body centered cubic torsional texture in the stir zone, a sharp transition in grain size from the thermo-mechanically affected zone into the stir zone, and an asymmetric reduction in hardness across the weld, all of which were sensitive to weld parameters. Oxide particles were significantly coarsened by friction stir welding, resulting in a complete loss of particle strengthening. Base metal MA956 mechanical properties were determined up to 600° C, and the effect of friction stir welding on these properties was directly correlated to the evolved microstructure. Grain refinement is a dominant strengthening mechanism in the base metal and for all friction stir welding conditions, as the welding process removed essentially all dislocation and dispersion strengthening contributions. Friction stir welded MA956 retains a majority of its high temperature strength, making the alloy and joining method a suitable candidate for a structural material in advanced nuclear reactor designs. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37582

Keywords: oxide dispersion strengthened steel, MA956, friction stir welding

DESIGN, TEST, AND EVALUATION OF A TRANSONIC AXIAL COMPRESSOR ROTOR WITH SPLITTER BLADES

Scott Drayton–Commander, United States Navy
Doctor of Philosophy in Mechanical Engineering
Advisor: Garth Hobson, Department of Mechanical and Aerospace Engineering
Co-Advisor: Anthony Gannon, Department of Mechanical and Aerospace Engineering

A new design procedure was developed and documented that uses commercial off-the-shelf software (MATLAB, SolidWorks, and ANSYS-CFX) for the geometric rendering and analysis of a transonic axial compressor rotor with splitter blades. Predictive numerical simulations were conducted, and experimental data were collected at the Naval Postgraduate School's Turbopropulsion Laboratory utilizing the Transonic Compressor Rig. This study advanced the understanding of splitter blade geometry, placement, and performance benefits. In particular, it was determined that moving the splitter blade forward in the passage between the main blades, which was a departure from the trends demonstrated in the few available previous transonic axial compressor splitter blade studies, increased the mass flow range with no loss in overall performance. With a large 0.91 mm (0.036 in) tip clearance, to preserve the integrity of the rotor, the experimentally measured peak total-to-total pressure ratio was 1.69, and the peak total-to-total isentropic efficiency was 72 percent at 100 percent design speed. Additionally, a higher-than-predicted 7.5 percent mass flow rate range was experimentally measured,

which would make for easier engine control if this concept were to be included in an actual gas turbine engine. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37616

Keywords: transonic, axial compressor, rotor, splittered, splitter blade, design tool

DETERMINING SNOW DEPTH USING AIRBORNE MULTI-PASS INTERFEROMETRIC SYNTHETIC APERTURE RADAR

Jack Evans–Lieutenant Colonel, United States Air Force
Doctor of Philosophy in Meteorology
Advisor: Fred Kruse, Department of Physics

Snow accumulation is a significant factor for hydrological planning, flood prediction, trafficability, avalanche control, and numerical weather/climatological modeling. Current snow depth methods fall short of requirements. This research explores a new approach for determining snow depth using airborne interferometric synthetic aperture radar (InSAR). Digital elevation models (DEM) are produced for Snow Off and Snow On cases and differenced to determine elevation change from accumulated snow. Interferograms are produced using Multi-pass Single Look Complex airborne Ku-band SAR. Two approaches were attempted. The first is a classical method similar to spaceborne InSAR and relies on determining the baseline of the interferometric pair. The second used a perturbation method that isolates and compares high frequency terrain phase to elevation to generate a DEM. Manual snow depth measurements were taken to verify the results. The first method failed to obtain a valid baseline and therefore failed. The second method resulted in representative DEMs and average snow depth errors of -8cm, 95cm, -49cm, 176cm, 87cm, and 42cm for six SAR pairs, respectively. Furthermore, Ku-band appeared to be a high enough frequency to avoid significant penetration of the snow. Results show that this technique has promise but still requires more research to refine its accuracy. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37622

Keywords: airborne SAR, digital elevation model, interferometric, InSAR, remote sensing, synthetic aperture radar, snow depth, Mammoth Mountain, snow volume

ENSEMBLE SENSITIVITY ANALYSIS OF A SEVERE DOWNSLOPE WINDSTORM IN COMPLEX TERRAIN: IMPLICATIONS FOR FORECAST PREDICTABILITY SCALES AND TARGETED OBSERVING NETWORKS

Paul Homan–Major, United States Air Force
Doctor of Philosophy in Meteorology
Advisor: Joshua Hacker, Department of Meteorology

Multiple mesoscale numerical weather simulations are conducted to evaluate whether Ensemble Sensitivity Analysis (ESA) is a useful tool for determining the sensitivity of a severe downslope windstorm (DSWS) in complex terrain to initial conditions and assimilated observations. A 96-member ensemble is implemented with 1.33 km grid spacing. Sensitive regions are found both upstream and downstream, based on a new forecast metric that indicates the potential for turbulence and strong winds reaching the Earth's surface. Approximating the effects of assimilating a perfect observation at these sensitivity locations, then executing non-linear ensemble forecasts, shows the linear approximations in ESA are reasonable. We analyze the roles of upstream wind and stability structures, and leeside conditions, in determining the strength and propagation of winds down the mountain slope and onto the adjacent plains. Results suggest that ESA is a viable method to identify observation locations to improve forecasts of fine-scale, non-linear, high-impact events such as DSWS. Also, 14 severe DSWS identified by the High Wind Alert System located at the USAF Academy in Colorado are modeled utilizing a deterministic WRF configuration. Analysis shows that non-wave-breaking events account

for the strongest DSWS and propagate further away from the mountains than breaking events at this location. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37639

Keywords: ensemble sensitivity analysis, downslope windstorm, complex terrain, numerical weather prediction, flow separation, breaking waves, vertically propagating wave, trapped waves, data assimilation, targeted observing, forecast predictability, bulk Richardson number, mesoscale, mesonet, observing system simulation experiment, WRF, mountain waves

OBSERVATIONS AND HIGH-RESOLUTION NUMERICAL SIMULATIONS OF A NON-DEVELOPING TROPICAL DISTURBANCE IN THE WESTERN NORTH PACIFIC

Andrew Penny–Civilian, Naval Postgraduate School
Doctor of Philosophy in Meteorology
Advisor: Patrick Harr, Department of Meteorology

Uncertainty still remains in determining whether a tropical cloud cluster will eventually develop into a tropical cyclone. During T-PARC/TCS-08, a tropical disturbance (TCS025) was closely observed for potential formation during five aircraft reconnaissance missions. However, similar to the outcome for the majority of such systems, TCS025 failed to intensify. This provided for an unprecedented dataset of a non-developing system, which included airborne ELDORA dual Doppler radar. An in-depth examination of observations revealed that TCS025 failed to develop due to vertical wind shear and misalignment of the circulation structure in the vertical. Poor vertical alignment kept the circulation exposed to negative environmental influences that impacted the inner-core thermodynamic structure. This weakened subsequent convection might otherwise have improved alignment and contributed to development. A multi-physics ensemble using the WRF-ARW model was employed to expand upon the observational findings. Simulations that developed TCS025 exhibited exaggerated convective precipitation processes and improved circulation alignment. Data assimilation experiments that incorporated aircraft and radar data provided improved initial conditions to examine the impact of a weak, misaligned circulation. Although convective precipitation processes were still over-represented, development of TCS025 was delayed, which allowed environmental factors to more severely impact TCS025 and limit its development. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37691

Keywords: tropical storm formation, TCS-08, T-PARC, airborne dual-Doppler Radar, dropwindsonde, ELDORA, SAMURAI, WRF-ARW, DART ensemble data assimilation

ASSESSMENT OF TROPICAL CYCLONE STRUCTURE VARIABILITY

Robert Stenger–Lieutenant Colonel, United States Air Force
Doctor of Philosophy in Meteorology
Advisor: Russell Elsberry, Department of Meteorology

The landfall of large hurricanes in densely populated areas has increased the awareness that tropical cyclone structure plays an important role in the destructive potential of a storm. A unique set of H*Wind analyses of Atlantic tropical cyclones during the 2003–2005 seasons is studied to better understand the internal and external mechanisms that lead to significant variability in surface wind structure. Secondary eyewall formation, asymmetric convection, land interaction, and environmental vertical wind shear were generally found to be mechanisms for radius of maximum wind increases, intensity decreases, and size of the radius of 34kt wind increases. Two modes of size changes were documented that may lead to 100km increases in 12–24 hours, or near-zero size changes when a sharper-than-average outer wind structure profiles are generated. The statistical relationships among the radius of maximum wind, intensity, and outer-core wind structure from this

sample may provide perturbed vortex initial conditions for an ensemble model to predict structure changes. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37723

Keywords: tropical meteorology, tropical cyclone structure, tropical cyclone prediction, western north Pacific typhoons, Atlantic hurricanes, H*Wind analysis, H*Wind analysis tool, ensemble modelling, secondary eyewall formation, asymmetric convection, land interaction, vertical wind shear

HYBRID ARCHITECTURAL FRAMEWORK FOR C4ISR AND DISCRETE-EVENT SIMULATION (DES) TO SUPPORT SENSOR-DRIVEN MODEL SYNTHESIS IN REAL-WORLD SCENARIOS

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Doctor of Philosophy in Modeling, Virtual Environments, and Simulation (MOVES)
Advisor: Don Brutzman, Department of Information Sciences
Co-Advisor: Phillip Pace, Department of Electrical and Computer Engineering

While the application of a time-step approach in modeling C4ISR in Missile Defense Warfare (MDW) suffers from inaccurate time estimation and relatively slow speed, Discrete Event Simulation (DES) can elegantly satisfy these shortages. However, current DES frameworks typically rely on detailed efforts in event analysis for numerous replications before software modification of the simulation scenario can be meaningful. Such approaches have limited adaptability, especially regarding flexibility of scenario design and customizability of entity definition. This dissertation proposes an improved DES framework, Adjustable and Extensible Modeling Framework DES (AEMF-DES), which embeds the primary principles of a topical theme into a program to perform adjustable and extensible studies that can be explored by the analyst. To prove the feasibility of AEMF-DES, a Missile-Defense Simulation application (MDSIM) is also developed during this research. MSDIM simulates the C4ISR processes in Missile Defense Warfare and can estimate the overall effectiveness of a defender's deployment or attacker's strategy. Additionally, based on the interest in sensor deployment evaluation, a k-coverage rate problem is also studied. Current k-coverage algorithms can only deal with binary and omnidirectional sensor models, which cannot provide enough simulation fidelity if higher resolution is needed. An improved k-coverage rate algorithm is proposed in this research to handle the probabilistic and directional sensor models. A separate simulation test successfully demonstrates the feasibility of this new calculation algorithm in estimation of the k-coverage rate problem with probabilistic and directional sensor models. Considered together, the architecture implemented in this example software illustrates the value of integrating hybrid simulation techniques to support C4ISR analysis related to Missile Defense Warfare. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37598

Keywords: simulation, discrete event simulation, DES, computer managed DES, AEMF-DES, missile defense warfare, MDW, K-coverage rate

A GENERALIZED ORIENTEERING PROBLEM FOR OPTIMAL SEARCH AND INTERDICTION PLANNING

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Doctor of Philosophy in Operations Research
Advisor: Johannes Royset, Department of Operations Research

In order to support search planning for counterdrug operations, we introduce a generalized Orienteering Problem (OP) where transit on arcs in a network and reward collection at nodes both consume a variable amount of the same limited resource. We exploit this resource trade-off through a specialized branch-and-bound algorithm that relies on partial-path relaxation problems, which often yield tight bounds and lead to substantial pruning in the enumeration tree. We present the Smuggler Search Problem (SSP) as a real-world application of our generalized OP. Numerical results show that our algorithm applied to the SSP outperforms

standard mixed-integer nonlinear programming solvers for problems with seven or more targets. We present model enhancements that allow practitioners to represent realistic search planning scenarios. We investigate how evolving uncertainty in planning data can be addressed by a multi-stage stochastic programming model. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37694

Keywords: counterdrug operations, mixed-integer nonlinear programming, optimal search, orienteering problem, search and interdiction, search theory, smuggler search problem, vehicle routing problem

STRATIFIED FRONTS IN WELL-MIXED ESTUARIES

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Doctor of Philosophy in Physical Oceanography
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The occurrence of tidal intrusion fronts in a well-mixed estuary is demonstrated through both model simulation and field observation. Strong vertical mixing in well-mixed estuaries typically does not allow for development of stratification, which is a defining feature of tidal intrusion fronts. New methodology to compute a mutual realization surface of critical width and depth from model output is described that evaluates how the geometry of a basin releases tidal inflow from the hydraulic control of an inlet and the resulting front character. Force balance relationships of these features are evaluated in three dimensions for the first time. From this, Froude angle techniques are adapted to assess and predict how the geometry controls the behavior of the front after it is formed. Intrusion fronts observed in the field do not precisely conform to the conceptual model, but a modest field validation of Froude angle usage informs an axis rotation that results in agreement with established hydraulic theory. Frontogenetic mechanisms are proposed from the observations to describe the importance of morphological complexity and water mass segregation to the occurrence of bathymetrically induced confluent subduction in a well-mixed estuary. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37742

Keywords: physical oceanography, estuary, tidal intrusion front, Froude number, Froude angle, frontogenesis, prediction

NO RETREAT: THE FAILURE OF SOVIET DECISION-MAKING IN THE AFGHAN WAR, 1979–1989

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Advisor: Daniel Moran, Department of National Security Affairs

In 1979, the Soviet Union invaded Afghanistan to settle a quarrel among competing factions within the recently installed communist government and to suppress the anti-communist resistance that the Afghan government's ideology and conduct had inspired among the population. This dissertation examines Soviet decision-making surrounding what proved to be a decade-long military effort. It focuses on the way political decision-making at the highest levels of the Soviet state shaped the war's origins, conduct and outcome, with particular attention to the politics and inner workings of the Politburo, the most senior collective decision-making body in the government. Like most wars, the outcome of the Soviet-Afghan War appears overdetermined in retrospect. There is no claim here that the Soviets' defeat can be attributed to their having missed some readily apparent path to victory, nor a claim that the Afghan war would have been won but for mistakes made in Moscow. Yet it remains true that the senior leadership of the Soviet Union quickly became aware that their strategy was unraveling, that their operational and tactical methods were not working, and that the sacrifices they were demanding from the Soviet people and military were unlikely to produce the results they hoped for. They persisted nonetheless. This study explains why and how that happened, as viewed from the center of the Soviet state. From that perspective, three sources of failure stand out: poor civil-military rela-

tions; repeated and often rapid turnover at the very summit of Soviet leadership; and the perception among Politburo members that Soviet global prestige and influence were inexorably tied to the success of the Afghan mission, which caused leaders to persist in their pursuit of a policy long after it was clearly unobtainable. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37626

Keywords: Soviet-Afghan War, Politburo, decision-making, civil-military relations

IMPERIAL SENATE: AMERICAN LEGISLATIVE DEBATES ON EMPIRE, 1898–1917

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Doctor of Philosophy in Security Studies
Advisor: Daniel Moran, Department of National Security Affairs

In 1898, the United States forced Spain to release the colonies of Cuba, Puerto Rico, Guam, and the Philippine Islands. Over the next 20 years, the U.S. Senate debated whether to keep, how to govern, and finally how to set some of those territories free while making others permanent possessions of the republic. These debates reveal a legislature, and by extension a nation, reevaluating its basic principles and changing place in the world. A review of international relations and domestic politics preceding the Spanish-American War establishes a pattern of legislative deference. Examination of pivotal debates spanning the post-war American imperial period shows how the U.S. Senate broke that pattern by seeking an expanded foreign policy role. Each inquiry highlights the effects of partisanship and domestic politics on ostensibly international matters. It is well known that the Senate failed to assert its foreign policy authority over the executive. Yet its efforts to do so cast light on the politics of the period, on how decisions about the acquisition and fate of America's colonies were justified, and on how deeply contested these issues actually were. After extensive debate, the Senate deliberately chose imperialism. This paper explains how and why it did so. See full disseration text: https://calhoun.nps.edu/public/handle/10945/37715

Keywords: American imperialism, Spanish-American War, Cuba, Puerto Rico, Philippines, Guam, senate debates on imperialism, Foraker Act, Treaty of Paris, Jones Act, Platt Amendment, Teller Amendment, Jones-Shafroth Act, Army Appropriations Act of 1901, westward expansion, organic acts, organized non-incorporated territories

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MASTER OF ARTS IN SECURITY STUDIES

THE BENEFITS OF COLLABORATIVE PROCESSES FOR ESTABLISHING ALL HAZARD INCIDENT MANAGEMENT TEAMS IN URBAN AREA SECURITY INITIATIVE REGIONS

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Second Reader: Ronald Perry

In 2008, consistent with past practice, the Phoenix Urban Area began a collaborative process to establish three All Hazards Incident Management Teams (AHIMT) with a three-year timeline for project completion. In 2013, one team is functional and the other two AHIMT are not yet deployable. This research constitutes a case study of the 2008 Phoenix AHIMT process and seeks to identify challenges and obstacles to collaboration. The findings of this case study of collaboration in the Phoenix Urban Area found that participants in the process viewed positively the emphasis by leaders on collaboration, the frequency that collaboration took place, and the benefits that arose from mutual collaboration. There is minimal agreement among participants about how much collaboration has taken place in developing the AHIMT program. The benefits of collaboration are believed to include the sharing of resources, developing positive relationships with other agencies, reducing operational costs, and providing a common framework for identifying and solving problems. These findings support the following recommendations for using collaboration in regional initiatives: an overall program strategy document that addresses the need for and commitment to collaboration, governance, personnel, competency, remaining relevant, and an exercise schedule. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37576

Keywords: collaboration, All Hazards Incident Management Teams, AHIMT, Incident Management Teams, IMT, leadership, Urban Area Security Initiative, UASI, regionalization, Phoenix, Arizona

MAXIMIZING INTELLIGENCE SHARING WITHIN THE LOS ANGELES POLICE DEPARTMENT

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Second Reader: Patrick Miller, Center for Homeland Defense and Security

After the terrorist attacks in New York, law enforcement agencies at all levels find themselves grappling with their additional responsibilities now that homeland security is tantamount, along with the war on drugs and gangs still being a constant struggle. From the time of the attacks to the present day, most agencies are doing more work with fewer people; there is no funding, equipment, or new officers to replace the ones retiring. Officers everywhere are not only overwhelmed, but, more critically, they are also under-estimated and under-trained. As a result of the attacks, officers are adding homeland security strategies into their existing crime prevention measures. This thesis will suggest ways in which one agency, the Los Angeles Police Department, can maximize its resources, training and equipment, thus capitalizing on

the intelligence needed to be a leader in the identification of, prevention of, and response to a terrorist attack. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37580

Keywords: Los Angeles Police Department, LAPD, homeland security, terrorism, war on drugs, war on gangs, gang violence, Israeli National Police

TWITUATIONAL AWARENESS: GAINING SITUATIONAL AWARENESS VIA CROWDSOURCED #DISASTER EPIDEMIOLOGY

This thesis has been recognized as outstanding by its department.

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Advisor: Robert Josefek, Center for Homeland Defense and Security
Co-Advisor: Lauren Fernandez, Center for Homeland Defense and Security

Public health and other agencies need situational awareness to respond effectively to disasters or other incidents. Traditional means of obtaining this information require significant time and personnel. Social media is becoming increasingly popular among American citizens, and research is demonstrating that it may be a useful tool for bolstering information about unfolding events. This research analyzed the potential of the microblogging service Twitter in providing situational awareness. Tweets from a major snowstorm affecting the state of Massachusetts were collected, coded for content, and compared to traditional public health methods. The results indicate that Twitter can provide a rich source of data for responding agencies. Still, the immense volume of conversations makes extracting useful information in a timely manner a significant challenge. Practical approaches uncovered during this research can help agencies with nascent social media surveillance programs begin to unearth the valuable information that Twitter contains. Collaboration with information technology experts could allow public health and other responding agencies to create even greater value from social media platforms. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37594

Keywords: situational awareness, social media, Twitter, disaster epidemiology, public health, Internet, Web 2.0, emergency response, emergency management

MAKING U.S. SECURITY AND PRIVACY RIGHTS COMPATIBLE

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Co-Advisor: Christopher Bellavita, Department of National Security Affairs

The terror attacks against the United States on September 11, 2001 necessitated changes in the way domestic intelligence agencies and services conducted information-collection activities to protect against further attacks. Congress acted quickly to prevent the next attack by expanding government authority under the USA PATRIOT Act and the Federal Intelligence Surveillance Court. This gave domestic intelligence services the tools needed due to advances in technology that allowed terror organizations and suspects to travel, communicate, raise money and recruit using the Internet. Safeguards were written into the enhanced authority to protect against privacy abuses by government. Ten years after 9/11, civil-liberties advocates called for more transparency, more privacy protections, and better oversight because of past abuses by government officials operating in the name of national security. Leaks about government spying on U.S. citizens have heightened the balance debate between security and privacy. Privacy or security is not a zero-sum game. A policy that incorporates an adversarial process in the FISC and a streamlined oversight mechanism in Congress for more effective oversight, and the release of redacted classified documents

to educate the public about surveillance techniques, would instill more balance and greater public trust. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37603

Keywords: USA PATRIOT Act, Federal Intelligence Surveillance Court, Domestic Intelligence Services, oversight, adversarial process, surveillance techniques, privacy, information collection

POLICY IN CONFLICT: THE STRUGGLE BETWEEN ENVIRONMENTAL POLICY AND HOMELAND SECURITY GOALS

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Co-Advisor: Lauren Fernandez, Center for Homeland Defense and Security

Since the 1970s, every American president and many Congressional leaders have called for national energy independence as a top policy priority. Among many reasons the United States has been unable to deliver on this goal over four decades are certain environmental policies that may tend to inhibit efficiency in fuel consumption of vehicles. This study examines the unintended consequences of certain environmental policies for American homeland security. The analyses suggest that some environmental policies may have a deleterious effect on the ability of the United States to achieve a level of energy efficiency in the transportation sector that could contribute to achieving national energy security. This study suggests ways to achieve a level of sustainable energy security by reducing consumption in the most important petroleum consuming sector, that of automobile transportation. Some U.S. oil dollars may be directly supporting terrorist organizations or, at a minimum, go toward supporting the spread of radical Islamic Salafism, which is inimical to U.S. and Western interests. This inquiry examines evidence to show that America's continuing dependence on other foreign oil, especially oil from the Middle East, is perilous to homeland security and compels limits to U.S. freedom of action in foreign affairs. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37605

Keywords: policy conflicts, environmental policy vs. homeland security goals, energy security, petrodollars supporting Islamic radicalization and terrorism

THE IMPACT OF RESOURCE WEALTH ON ECONOMIC GROWTH, GOVERNANCE, AND CONFLICT IN AFGHANISTAN

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Second Reader: Thomas Johnson, Department of National Security Affairs

Immense natural resource wealth lies buried within Afghan soil. The potential revenue stream resulting from the extraction of minerals and hydrocarbons from the country has been identified as a replacement for international aid and, ultimately, as a catalyst for self-sustaining economic growth. Political instability and the potential adverse effects of resource abundance in underdeveloped countries, however, pose challenges to this assertion. Afghanistan's long history of aid dependence is used as a proxy measure in this study to assess the impact of large revenue streams on political and economic institutions. While research found that foreign aid had a detrimental effect on institutional quality within Afghanistan, the study also determined that a critical difference exists between the method in which aid was dispersed and the manner in which large-scale resource revenue payouts will necessarily occur within the country. Initial observations suggest that the realization of the country's economic potential has positively affected government institutions charged with developing the mining sector. While analysis of aid programs in the country shows flaws in governance and monetary policies, there are indications that the incentives induced by the emerging mining sector

have triggered a shift toward a future-oriented development strategy amongst political and economic leaders. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37608

Keywords: Afghanistan, resource curse, economic growth, economic development, patronage networks

THE SUBMERSIBLE THREAT TO MARITIME HOMELAND SECURITY

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Second Reader: Alan Tubbs

Small submersible vessels have been used for years by nation-states, terrorist groups, and criminal organizations to achieve operational objectives. These entities have sought to capitalize on the overriding tactical advantage of submersible technology, which is stealth. For example, drug trafficking organizations in Central and South America have been routinely using self-propelled, semi-submersible vessels to clandestinely transport large quantities of illicit drugs to North America. Small, submersible vessels can also be nefariously used in the maritime domain to transport persons or weapons, or they could be used as waterborne improvised explosive devices. Terrorists and criminals are complex adaptive adversaries and are driven to innovate when confronted with threats to their operational effectiveness. Innovation and adaption are driving these foes to leverage disruptive technology towards the development or acquisition of fully-submersible vessels. Furthermore, there is a growing population of privately owned submersibles within the United States that policymakers have little visibility of. Homeland security policymakers lack adequate situational awareness regarding the vulnerabilities, threats, and consequences to the maritime transportation system from the malicious use of submersibles. The core challenge for the maritime homeland security enterprise with regards to submersibles is developing effective strategies to mitigate their potential risk. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37609

Keywords: Department of Homeland Security, disruptive technology, drug trafficking organization, maritime domain awareness, maritime homeland security, self-propelled fully-submersible, SPFS, self-propelled semi-submersible, SPSS, small vessel security strategy, SVSS, strategic risk, submarines, terrorism, United States Coast Guard, waterborne improvised explosive device, WBIED

GERMANY, THE EUROPEAN UNION, AND THE EURO: THE PRIMACY OF POLITICS IN TREASURE

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Advisor: Donald Abenheim, Department of National Security Affairs
Co-Advisor: Mikhail Tsypkin, Department of National Security Affairs

The Federal Republic of Germany has risen to take a leadership position in the Eurozone sovereign debt crisis. This quasi-depression has highlighted the economic interdependence of the Eurozone member states and has exposed the fundamental weakness of the lack of a political union between members to coordinate a timely fiscal response. This thesis examines why the Federal Republic of Germany became the cornerstone for Eurozone monetary stability; how the country contributed and what it has sacrificed thus far towards the crisis; and surveys what Germany must do in the future to ensure European financial stability. Germany's current commitment to the continent is examined here through the treaties that economically linked the European nations and formed the foundation for the Eurozone. In addition, the weaknesses of periphery member states that contributed to the crisis and the substantial sovereign economic bailouts and recovery packages that have been enacted by the Troika are analyzed. The thesis then examines the three options that are available to the Eurozone: to continue to muddle through the crisis, to enact substantial reforms, or to splinter and break up the Union.

The results support the choice for greater political integration and the need for the issuance of Eurobonds. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37610

Keywords: Germany, European Union, euro, eurozone sovereign debt crisis, European economy, eurobonds

AN EXAMINATION OF THE COLLATERAL PSYCHOLOGICAL AND POLITICAL DAMAGE OF DRONE WARFARE IN THE FATA REGION OF PAKISTAN

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Advisor: Fathali Moghaddam, Center for Homeland Defense and Security
Second Reader: David Brannan, Center for Homeland Defense and Security

This research will examine the collateral psychological and political damage of the U.S. drone warfare program on Pakistani society in the Federally Administered Tribal Areas (FATA), to determine if this is an effective, proactive homeland defense tactic. The use of drone aircraft by the U.S. government has increased worldwide since this evolving technology was first utilized in 2001. Each drone strike impacts militants, noncombatants, and ordinary civilians. The potential for collateral damage and civilian casualties may overshadow the tactical gain of even successful drone strikes by inspiring radicalization and creating recruiting opportunities for militants. The findings of this research will recommend an alternative framework from which to evaluate the effectiveness of drone warfare based on the collateral psychological and political impact on society in this region. Traditional studies of drone warfare have tended to analyze from a tactical perspective. The examination of drone warfare, based on the damage done to the psychological experiences and political attitudes of FATA residents who may turn against the United States, provides policy makers with the ability to better assess the impact of drone strikes on communities and determine the optimal situation to leverage this lethal tactic while minimizing negative outcomes. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37611

Keywords: drone, Pakistan, FATA, Pashtun, accidental guerilla, honor and shame, relative deprivation, displacement of aggression

POST-CONFLICT RETURNEE REINTEGRATION: A CASE STUDY OF SOUTH SUDAN AND THE LIVELIHOOD APPROACH

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Second Reader: Anne Baylouny, Department of National Security Affairs

Post-conflict societies emerging from protracted violence often struggle in the critical transition from short-term oriented emergency relief assistance, functioning as an immediate stabilizing mechanism during decades of protracted conflict, to longer-term solutions intended to rebuild the nation. This post-conflict evolution is complicated by the potentially destabilizing reintroduction of returning refugees and internally displaced persons. Using South Sudan as the case study, this thesis analyzes the short- and long-term tradeoffs and implications of immediate versus durable repatriation strategies for stabilization and reconstruction of post-conflict societies. I argue that reintegration strategies must provide a long-term development approach; a long-term approach directly contributes to the future prospects and viable stability of a post-conflict environment. This thesis concludes that while there have been concerted efforts towards contributing to the reintegration of returnees in South Sudan, the critical element lies in the ability of such post-conflict nations to provide long-term sustainable opportunities for livelihoods in order to obtain and sustain peace and stability. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37619

Keywords: performance-based design, arson, physical security, permanent countermeasures, Interagency Security Committee, fire models

THE EVOLVING ARCTIC: CURRENT STATE OF U.S. ARCTIC POLICY

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Advisor: Lauren Wollman, Center for Homeland Defense and Security
Co-Advisor: Kathleen Duignan, United States Coast Guard

The Arctic environment is in a state of flux, and the U.S. government must be prepared to handle the evolution and capitalize on the opportunities. Once barren and desolate, the Arctic is slowly coming to life with industry and commerce brought about by receding ice conditions. Along with that comes the need for a comprehensive and actionable Arctic policy. The other Arctic nations that ring the North Pole are quickly adapting to the shifting Arctic. Unlike the United States, they have established Arctic policies, are implementing plans to operate in the region, and are taking advantage of the opportunities that this new frontier has to offer. The U.S. framework is the National Strategy for the Arctic Region. The plan is short on detail and aspirational in nature. It lacks clear direction and authority. The United States has yet to commit to its role as an Arctic nation. The U.S. Arctic lacks infrastructure, such as a deep-water port, a joint military base, and additional heavy icebreaker assets. Additionally, there is no lead agency that has authority and funding to carry out U.S. Arctic objectives. Under the current state of affairs, the United States is vulnerable to security, economic, and sovereignty issues in the Arctic. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37620

Keywords: Coast Guard, Arctic, Arctic Council, Canada, U.N. Convention on the Law of the Sea, Department of Defense, Department of Homeland Security, polar icebreaking

ROOTS AND CAUSES THAT CREATED THE PKK TERRORIST ORGANIZATION

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Second Reader: Erik Dahl, Department of National Security Affairs

It is important to understand the factors leading to the Kurdistan Workers Party's (PKK) foundation to take the necessary steps to avoid current and new terrorist activities in Turkey. This thesis research examines three main incentives that led to the PKK's creation and continuation beyond any governmental policies or colonial arguments. Besides many others, there are three main instruments through which the PKK found the means to start and develop an armed campaign: Turkey's political atmosphere in the 1960s, 1970s and 1980s; Abdullah Öcalan, the leader of the PKK; and foreign ambitions over Turkey. The main objective of this thesis is to find out what has made the PKK unique and what sets it apart from other illegal organizations and terrorist groups. A study of the origins of the group and its leader, this thesis demonstrates the PKK's ability to orient itself to the shifting environment in Turkey and in the world, and how it benefited from the chaotic atmosphere of Turkey during its foundation years. Successive chapters will touch upon the group's leader, Abdullah Öcalan, as well as the countries that supported the PKK. The conclusion will suggest possible long-term peace and stability solutions that Turkey might take. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37625

Keywords: terrorism, Partiya Karkern Kurdistan, PKK, Turkey, military coup, Abdullah Öcalan, counterterrorism, Kurds, insurgency

TERROR-STING OPERATIONS IN THE MUSLIM COMMUNITY: DEVELOPING RECOMMENDATIONS FOR IMPROVING PUBLIC SUPPORT

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Advisor: Lauren Wollman, Center for Homeland Defense and Security
Second Reader: Joseph Gallucci, New York City Police Department

This thesis analyzes the criticisms surrounding the use of terror sting operations by law enforcement agencies for the purpose of developing recommendations to increase public support, particularly among the American Muslim population. The relevant literature is replete with criticisms surrounding the behavior of civilian informants during terror sting operations and the effect those actions have on community relations. Critics claim that terror sting operations constitute spying, profiling, and entrapment. Contrary to that claim, however, is the fact that these operations have successfully withstood intense legal scrutiny; trials in which defendants are accused of carrying out these plots have always resulted in conviction. The goal of this thesis, therefore, is not to argue that the operations not be conducted, but, rather, to identify improvements that law enforcement agencies can implement to minimize the perception that terror sting operations are a form of entrapment or profiling. The results of this research are recommendations centered on addressing the most common or legitimate criticisms. The goal of these recommendations is to minimize the negative impact on community relations while simultaneously improving the quality of terror sting operations. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37640

Keywords: best practices, public information

ACTIVE SHOOTERS: IS LAW ENFORCEMENT READY FOR A MUMBAI STYLE ATTACK?

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Co-Advisor: Patrick Miller, Center for Homeland Defense and Security

Between April 16, 2007, and December 14, 2012, the United States saw 25 mass shootings, seven of which occurred in 2012. A 2009 report by the U.S. Department of Homeland Security suggested that the United States will be the target of a terrorist act that could cause a high number of casualties. The November 26, 2008 attack on Mumbai is a transparent example of how determined terrorists, trained to die fighting, can bring a large metropolitan city to its knees. It is entirely probable that Mumbai-type attacks could occur in the United States. Since the local law enforcement responds to attacks in progress, any active shooter event would be handled by the local jurisdiction. Many law enforcement agencies have begun to incorporate tactical plans to respond to Mumbai-type terrorist attacks. This thesis focused on police preparedness of select large metropolitan law enforcement agencies for potential Mumbai-type terrorist attacks. A comparative analysis of these police agencies was conducted, which showed that the frequency of training was found to be varying and inadequate by these agencies. A similar concern was that none of the agencies had equipped all the police officers with rifles, which were deemed critical to engage well-equipped active shooters. It is the conclusion of the thesis that gaps in preparedness exist and law enforcement organizations have room for improvement. It was also concluded that agencies need to enhance communication capability between neighboring jurisdictions and focus on triage of the victims during the early stages of attacks when medical personnel would be unable to approach. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37645

Keywords: active-shooter, multi-assault counter terrorism action capabilities, MACTAC, immediate action rapid deployment, IARD, unmanned aerial vehicles, UAV, command and control, incident command system, ICS, North Hollywood bank robbery, self-deployment, Los Angeles Police Department, LAPD, Las Vegas Metropolitan Police Department, LVMPD, New York Police Department, NYPD, Chicago Police Department, CPD)

ASSESSING VICTORY: HOW TO IDENTIFY THE CORRECT MEASURES OF SUCCESS IN COUNTERINSURGENCY WARFARE—THE CASE OF THE FARC IN COLOMBIA

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Second Reader: Kalev Sepp, Department of Defense Analysis

This thesis applies net assessment to the Colombian Government's protracted campaign against the Revolutionary Armed Forces of Colombia (FARC) in order to determine proper metrics to track progress in counterinsurgency warfare. Net assessment is used to analyze potential centers of gravity to determine the correct center of gravity. Armed with the correct center of gravity, potential critical vulnerabilities are examined. Finally, once the correct critical vulnerability is identified, metrics are assessed in order to determine which metrics accurately track progress in attacking the identified center of gravity. As debate exists as to the true nature of the FARC, this thesis applies the above methodology to the FARC as both an ideological insurgent group and a narco-criminal organization, and identifies different centers of gravity, critical vulnerabilities and metrics in each case. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37654

Keywords: Colombia, FARC, metrics, net assessment, counterinsurgency

THE DIFFERENTIAL IMPACT OF WOMEN'S PARTICIPATION IN THE ARAB SPRING

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The Arab Spring protests in 2011 uprooted regimes, challenged authoritarian leaders, and provided protesters with new tools for mobilization. The use of social media and the involvement of women in public protests indicated changing protest repertoires and movement demographics in many countries. When women protested in 2011, they mobilized both physically and virtually. Assessing the influence women exert in social movements through social media can provide insights into factors that make a social movement successful. This thesis asserts that women physically mobilized to participate in the Arab Spring protests in Egypt, Yemen, and Bahrain. In Egypt and Bahrain, women also mobilized virtually using social media, while, in Yemen, women participated through traditional forms of social mobilization. An assessment of Twitter data in Egypt and Bahrain indicates that women communicated out to others more than their male counterparts, while men received more information from others. Data also indicates that women followed significantly more sources of information than men, thus contributing to the diversity of online protest networks. Notably, women represented nearly 50 percent of the most connected users in the Egyptian Twitter data, communicating to nearly twice as many users and following four times as many information sources as their male counterparts. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37655

Keywords: Egypt, Bahrain, Yemen, Arab Spring, social media, Twitter, social movements, social networking, protest, revolution, gender participation, non-violent protest

UNITY OF COMMAND FOR FEDERAL CONSEQUENCE MANAGEMENT

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The United States eventually will face an existential catastrophe. An existential catastrophe would result in cascading effects extending well beyond the physical boundaries of the event. When studying the federal response to major disasters, it is apparent that higher levels of presidential interest provide a positive impact on results. The lack of coordination of federal response efforts and the inability of the president to impose his will to marshal fully federal resources effectively were major problems identified after Hurricanes Katrina and Andrew. The inability of the federal government to coordinate the federal response efficiently to a catastrophe appears throughout 60 years of modern federal disaster response. This thesis argues that the most efficient way for the president to supervise the federal response to an existential catastrophe is to delegate authority for operational decisions to a single federal official, which would allow the president and his cabinet to focus on strategic decisions. The Federal Emergency Management Agency Administrator, who would be supported by an empowered Emergency Support Function Leadership Group, with authority to direct all agency capabilities released to them by the president and their agencies, would lead the portion of the federal operational response formerly known as consequence management. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37664

Keywords: unity of command, federal disaster response, Stafford Act, emergency management, existential catastrophe

THE SCALE SHIFT OF COCALERO MOVEMENTS IN PERU AND BOLIVIA

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This thesis seeks to explain variation in the outcomes of cocalero mobilization in Peru and Bolivia. When cocaine became a popular drug in the United States in the late 1970s and early 1980s, governments of the coca-producing countries in the Eastern Andes began implementing policies that included forcible eradication of coca plants, often with U.S. assistance. Cocaleros in Bolivia not only protested against government policy but also formed a national movement using political alliances that included indigenous and labor unions. In contrast, Peru's cocaleros also mobilized against forced eradication, but a coherent national movement never materialized. This is a problem because social movement literature indicates Peru and Bolivia share many factors that should contribute to increasing levels of mobilization: decentralization measures, a consistent threat from national and international entities, neoliberal reform and backlash, and a recent turn to the political left. This thesis argues that cocalero movements first require political associational space before they can expand their movement through political alliances and achieve an upward shift in the scale of their movement. Furthermore, it finds that when cocalero movements use credible and resonant frames of protest, they are more likely to mobilize broader support and realize their goals. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37665

Keywords: Bolivia, Peru, Cocaleros, social movements, mobilization, frames of protest, scale shift

IMPLEMENTING THE NATIONAL FRAMEWORK FOR A BIOTHREAT FIELD RESPONSE MISSION CAPABILITY

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Since the 2001 anthrax attacks, communities have been responding to a sample surge of suspicious mailings. Each event has the potential to be an act of bioterrorism involving a deadly pathogen and thus requires a timely response in order to evaluate the risk to public safety. Stakeholders from federal and state governments and industry have recognized the need to develop a mission capability for responding to these suspicious events. The framework for a biothreat field response mission capability advocates the use of innovative detection technology in support of a risk assessment concept of operation. Implementing the framework will require federal and state collaboration and will establish local certification training standards, field-based proficiency and competency assessment exercises, and state response plans that reflect national guidance. This research describes the critical elements of a bioresponse framework, the current status of framework adoption at the state level, and recommendations for a three-phased implementation model. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37668

Keywords: biothreat, bioterrorsim, public safety actionable assay, hazard assessment, biological assessment, bioresponse framework, weapons of mass destruction, WMD, chemical, biological, radiological, nuclear, explosive, CBRNE)

ARMS CONTROL AND MISSILE DEFENSE: EXPLAINING SUCCESS AND FAILURE IN U.S.-RUSSIAN COOPERATION

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Co-Advisor: Michael Glosny, Department of National Security Affairs

Russia can no longer be considered a world superpower, but it remains a great power in terms of strategic global security. Russia's importance is based on its nuclear arsenal and permanent seat on the United Nations Security Council. This research analyzed arms control and ballistic missile defense (BMD) in order to explain the success and failure of cooperation between the United States and the Russian Federation. Utilizing international relations theory, realist and constructivist frameworks were applied to two separate case studies: U.S.–Soviet cooperation on the Intermediate Nuclear Forces Treaty and U.S.–Russian failure to cooperate on BMD. Each case was started with material factors that opened the opportunity for the Soviet and Russian Federation elite to be responsive to new ideas. The elite then turned to the state's intellectual entrepreneurs to find new ideas. In the case of the Soviet era, the elite chose to cooperate due to the influence of the international organizations they were associated with. In the present day, the elite, many of whom have a background in the Soviet and Russian Federation secret service, have chosen to defect from cooperation due to the socialization received during their time as KGB or FSB officers. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37676

Keywords: Russia, United States, ballistic missile defense, BMD, arms control, cooperation, international relations, realism, constructivism

CRISIS IN HONDURAS: THE SEARCH FOR ANSWERS TO THE REMOVAL OF PRESIDENT MANUEL ZELAYA

This thesis has been recognized as outstanding by its department.

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The removal of presidents from office in Latin America has generally occurred under delineated constitutional procedures since the military governments of the mid-20th century returned to their barracks. Many theories on presidential removal have been tested among numerous cases, yet none alone can explain the Honduran political crisis of 2009, which led to the ouster of constitutionally elected president Manuel Zelaya. The situation harkened back to the days when military coups were prevalent as the armed forces, acting under the authority of a court order, arrested the president and illegally expatriated him to Costa Rica. Honduran elites feared Zelaya's shift to the new radical left in Latin America and his alleged desire for reelection through his proposal for a referendum calling for the election of a constituent assembly. Responding to this fear, the Congress and Supreme Court acted to remove the president, while the military's decision to expatriate Zelaya stemmed from a legacy of leftist hatred. This thesis tests several elements of presidential removal theories against the Zelaya incident and argues that no one theory on its own can thoroughly answer the question; rather, it is necessary to incorporate several elements of each theory while examining the actions of the military and the courts to arrive at the answer. From a comparative analysis of past presidents, it argues that Zelaya's new ideology and desire for reelection ultimately were the needed factors to initiate his removal. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37679

Keywords: Honduras, Manuel Zelaya, reelection, new left, radical left, presidential removal

WHAT IS THE PROBLEM TO WHICH THE ANSWER WAS PUBLIC LAW 83-280: HOW IS IT WORKING OUT AND WHAT SHOULD WE DO NEXT?

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Second Reader: Carole Goldberg

This thesis explores the stakeholders' positions in relation to the implementation of Public Law 83-280 (PL 280). PL 280 mandated that states assume jurisdiction on reservation land. The thesis investigates how the uniqueness of this law has caused multi-dimensional problems, including collaborations/partnerships, familiarity with the law, compliance with the law, law enforcement effectiveness and/or impacts, cultural competence, and training/education. The main claim for this thesis is that PL 280 was written as an unfunded mandate without the consent or input from the Tribes and was enacted without clear guidance for implementation. The thesis investigates whether creation of a best practice model would create a collaborative relationship among Tribes and public safety agencies, communication among multiple disciplines, unified leadership and command on an incident, and improvement for all public safety planning. The research identifies what the existing relationships are, what is lacking at an operational level, what training is available, what the challenges have been, and what the next steps should be in order to improve the process of this law. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37914

Keywords: best practices, California Governor's Office of Emergency Services, OES, Intergovernmental Tribal Affairs Office, collaboration, Indian reservation, Indian Removal Act of 1830, Native American, Public Law 83-280, Termination Act, Tribal Emergency Management, Tribal Government, Tribal Law and Order Act, Tribal Public Safety

PERFORMANCE-BASED DESIGN FOR ARSON THREATS: POLICY ANALYSIS OF THE PHYSICAL SECURITY FOR FEDERAL FACILITIES STANDARD

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Although perhaps not so dramatic or newsworthy as chemical, biologic, radiologic, nuclear, or explosive attacks, intentionally set fires are identified security threats to federal buildings accessible to the public. The Department of Homeland Security Interagency Security Committee in 2010 adopted building construction standards that purport to give facility safety committees and building designers guidance on developing permanent countermeasures to 31 diverse threat scenarios described in the Design-Basis Threat. To assess the effectiveness of the permanent countermeasures options provided in the Physical Security Criteria for Federal Facilities, a performance-based approach to evaluating the design and construction features is recommended. Clearly articulated performance objectives and quantifiable characterization of the hazardous elements comprising the threat scenarios are essential to evaluating outcomes using a performance-based design approach. A mixed methods research approach is used to analyze the Physical Security Criteria for Federal Facilities standard to make policy recommendations that may enhance occupant safety and federal property protection from arson attacks. Computerized fire effects modeling is used to compare outcomes in non-military and non-postal federal facilities from a variety of simulated arson scenarios using commonly available accelerants. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37683

Keywords: performance-based design, arson, physical security, permanent countermeasures, Interagency Security Committee, fire models

ETHICAL DECISION-MAKING FOR HOMELAND SECURITY

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Co-Advisor: Anders Strindberg, Center for Homeland Defense and Security

The thesis suggests that homeland security personnel lack a uniform method to make sound and defensible ethical decisions. Building on a foundation of classical ethical thought, it is established that ethics are essential to the work of homeland security. Philosophical underpinnings include virtue ethics, deontology, utilitarianism, decision-making practices, and values common to the homeland security enterprise. Real-world case studies were examined in an attempt to understand and demonstrate what can happen if ethics are neglected, considered incompletely or incorrectly, or thoughtfully applied. Case studies include the response to Hurricane Katrina, motivation and thought behind terrorism, and the discussion on torture. Examples of good ethics programs were analyzed, including the Canadian Defense Ethics Program and the Wildfire Fire Leadership Development Program. From this research, a conceptual framework for understanding was developed. The DRIVE framework (Duty, Respect, Integrity, Vision, Ends/Expected outcomes) is proposed to give homeland security personnel the tools necessary to evaluate a situation, make a decision, and review it retrospectively. The framework is easy to remember, flexible to allow for individual differences, yet comprehensive enough to encompass classical ethical thought, common values, and decision-making. The thesis recommends developing an ethics-training program for homeland security, using DRIVE as a foundation. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37684

Keywords: ethics, decision-making, homeland security, virtue, values, deontology, utilitarianism, torture, terrorism, Canadian Defense Ethics Program, Wildfire Leadership Development Program, DRIVE

"WHAT THE HELL DO WE DO NOW?" A POLICY OPTIONS ANALYSIS OF STATE, LOCAL, AND TRIBAL LAW ENFORCEMENT PARTICIPATION IN IMMIGRATION ENFORCEMENT

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Many components come together to form not only the Department of Homeland Security (DHS), but also the larger homeland security enterprise across the country. State, local and tribal assets are part of the fabric of homeland security efforts, along with federal entities, in prevention, response and recovery. While immigration enforcement at the federal level was formally brought into DHS, state, local and tribal (SLT) enforcement agencies are potential partners in that effort, as pointed out in the 9/11 Commission Report. This thesis outlines some of the legal authorities for the use of local agencies, the diversity of approach and opinion in these efforts, and a cross-section of agency policies and SLT ordinances that direct enforcement efforts. Using a Policy Options analysis framework, SLT agency policies were examined and evaluated in five areas: effectiveness, legality, acceptability, efficiency, and implementation. Based on this research, it is apparent that not only is there a disparity of opinion and approach to immigration enforcement, there is also a lack of any policy at all for a majority of agencies. Recommendations for enforcement efforts include not only the importance of forming a policy, but also doing so in a collaborative way, including federal, SLT and community partners. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37685

Keywords: immigration enforcement, law enforcement, policy options, collaborative approach

THE IMPACT OF OBESITY ON NATIONAL AND HOMELAND SECURITY

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Second Reader: Lauren Wollman, Center for Homeland Defense and Security

Through a series of policy decisions, innovations, and a growing complex food system, the United States moved from a nation of people considered to be undernourished at one point to a nation with 100 million obese citizens. This radical change in our collective condition took place in less than one generation. This body composition change is impacting military readiness, military recruiting, first-responder readiness, and first-responder recruiting. Further, the impacts of obesity have an annual cost that is estimated to be nearly half a trillion dollars. In our mission to meet both acute and chronic homeland security needs, it is crystal clear that the human and economic burdens of obesity are substantial. Therefore, obesity is a homeland security issue. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37687

Keywords: obesity, food industry, homeland security, economics, military readiness

BEYOND HATE: COUNTERING VIOLENT EXTREMISM FROM THE WHITE POWER MOVEMENT

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Co-Advisor: Kathleen Kiernan, Center for Homeland Defense and Security

Counterterrorism efforts are a major focus for the homeland security enterprise. Throughout the world, however, efforts have largely focused on countering violent extremism from Islamist organizations. While Islamist terrorists have been responsible for more deaths in the United States, this research focuses on white power domestic

terrorism. It considers successful methods from the United States and United Kingdom but applies them to factions of the right-wing movement rather than Salafi-jihadist groups. This research is a case study comparison of former right-wing leaders, both of whom were associated with planned domestic terror plots. Significantly, the research included participation of individuals formerly active within the politically motivated Ku Klux Klan, and the religiously motivated The Covenant, The Sword, and the Arm of the Lord (CSA). It revealed a common anti-government theme between the vastly different groups, as well as the sociological underpinnings for participation in the Klan, within the theoretical framework of Social Identity Theory. While extremism is an unpleasant fact, perhaps violence can be mitigated, and having dialogue with those who once carried the torch of white power rhetoric may hold some answers or provide a starting point for successful counterterrorism efforts. See full thesis text: https://calhoun.nps.edu/public/handle/10945/38992

Keywords: KKK; Klan; CSA; Covenant, Sword, and Arm of the Lord; counterterrorism; countering violent extremism; Christian identity; white supremacist; white supremacy; SIT; social identity theory

PLAY WELL WITH OTHERS: IMPROVISATIONAL THEATER AND COLLABORATION IN THE HOMELAND SECURITY ENVIRONMENT

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Collaboration, though identified as a critical component to the Homeland Security (HLS) enterprise, can be difficult to achieve when working in complex HLS environments or addressing the wicked problems that permeate the enterprise. Federal doctrine and directives tell us that collaboration is important, but we are not told how to collaborate. Improvisational theater, on the other hand, is built on collaboration among performers to invent a narrative—performers who have been trained to collaborate. Based on a distillation of improvisational theater into five key principles, a comparative analysis of established collaborative models, and a case study of collaboration in the homeland security environment, I believe that those working within the homeland security enterprise can apply the same principles used by theatrical improvisers. This thesis proposes a new framework for collaboration, the Improvisational Theater Collaboration Model. Utilizing this framework to develop collaboration training or as a tool to assess the efficacy of collaboration in homeland security environments are two suggestions for further study into the Improvisational Theater Collaboration Model. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37692

Keywords: homeland security, improvisation, collaboration, collaborative capacity, multi-agency coordination, interorganizational collaboration, teaching collaboration, evaluating collaboration

PREPARING THE NATIONAL CAPITAL REGION TO CONDUCT A MULTIJURISDICTIONAL AND INTERDISCIPLINARY LAW ENFORCEMENT INVESTIGATION

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When the DC Sniper shootings occurred in 2002, local law enforcement (LE) agencies in the National Capital Region (NCR) did not have a framework in place to investigate a large-scale multijurisdictional investigation involving dozens of federal, state, and local LE agencies. As of 2013, the NCR still does not have a framework. This thesis used multiple sources of information and analysis to develop a list of recommendations directed to the NCR Police Chiefs Committee about how such a framework could be developed and what some of the features should be. The sources of information included lesson learned from the after-action

analysis of the DC Sniper case by the Police Executive Research Forum, academic research on collaboration, the National Incident Management System, and input from 19 multijurisdictional and intergovernmental subject matter experts (SME) in the NCR, including SMEs from the LE, fire, fusion center, and public information disciplines. In February 2013, the NCR Police Chiefs Committee endorsed the recommendations and started the process to create a framework for managing a multijurisdictional investigation in the NCR. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37697

Keywords: National Capital Region, NCR, law enforcement investigation, interdisciplinary, multijurisdictional, National Incident Management System, NIMS, regional, pattern crimes, collaboration, Gold-Silver-Bronze

PROTECTING AMERICA THROUGH BETTER CIVIC EDUCATION

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Co-Advisor: Wayne Porter, Global Public Policy Academic Group

How does civic education affect homeland security? A civic education curriculum that provides for the foundations of our youth's individual and collective identity may significantly contribute to the preservation of our democracy and enhance homeland security. Through a civic education, students can enhance their grasp of the concepts of our American representative democracy and learn the tenets of good citizenship, critical thinking, and the ability to self-govern. Presidential Directive Number Eight (8) clearly indicates the need for national preparedness using a whole of nation approach. The plan requires robust citizen engagement. To have an informed engaged citizenry and for a democracy to thrive, the populace must be educated. But there is no guidance or mention of the education of American youth or how such education may play a role in achieving the goals of national preparedness. The National Assessment of Educational Progress (NAEP) reported in 2010 that only 27 percent of the nation's fourth-grade students were proficient in civics. Only 22 percent and 24 percent of eighth-grade and twelfth-grade students, respectively, were proficient in the area. Civic education must provide youth with a personal and collective identity. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37698

Keywords: civics, education

OUTCOMES-BALANCED FRAMEWORK FOR EMERGENCY MANAGEMENT: A PREDICTIVE MODEL FOR PREPAREDNESS

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The homeland security community has struggled with a unifying system to support national preparedness, even though states and local jurisdictions have gone to great lengths to enhance their capability. State preparedness reports, with inconsistent ranking systems and measurement tools that are self-assessments of individual capabilities, lack a holistic connection. The literature suggests that a one-size-fits-all assessment system has limited comparative value and has not proven to answer to the unique risks each state faces. By looking at the risk posture in each state and the unique capability needs, a model emerges that includes existing quantitative information and combines it with qualitative efforts sustained in emergency management. This research will introduce a predictive model that balances value-added inputs with intended results enhanced by leadership, with the organizational processes and performance outputs enhanced by management, into a system that delivers the outcomes intended with preparedness and further comparing it with current policy on national

preparedness. With the demand by Congress to reconcile the treasury spent on homeland security, emergency management must find a system that balances both the measureable outputs and anecdotal impacts of preparedness that will guide each state toward improvement of its effort and secure strategies for future investments. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37710

Keywords: preparedness, outcomes, leadership, management, strategy, logic model

BEYOND LINE OF SIGHT (BLOS) COMMAND AND CONTROL (C2) CAPABILITY TO IMPROVE DISASTER RESPONSE AND RECOVERY

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Second Reader: Joseph Utschig, Department of Information Sciences

The ability to manage and monitor assets provides undeniable benefits in accomplishing mission objectives. The value of these capabilities is exponentially greater in disaster situations. This thesis introduces the BLOS C2 capability as a method of improving disaster response and recovery by enhancing situational awareness (SA) as well as command and control (C2). Demonstrated overseas in support of U.S. military battlespace coordination, the BLOS C2 capability promotes seamless communication and data sharing by means of sensor data and a truly common operational picture. Using the proven model that has improved mission effectiveness for the U.S. military, this thesis uses the Department of Homeland Security (DHS) and other levels of government involved in emergency response as case studies for analyzing the BLOS C2 capability in an effort to fill gaps in interoperability and information sharing. After analyzing each of these case studies, the application of the BLOS C2 capability will be considered and evaluated for potential benefits. Once these evaluations are made, recommendations will be offered that are aimed at implementing the BLOS C2 capability at all levels of government. These recommendations will provide DHS with courses of action that could enhance SA and C2, and potentially improve response and recovery efforts in the event of a disaster. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37713

Keywords: common operational picture, situational awareness, command and control, homeland security, network architecture, intelligence, surveillance, information technology, public service, information sharing, interoperability

IMPROVING THE ALL-HAZARDS HOMELAND SECURITY ENTERPRISE THROUGH THE USE OF AN EMERGENCY MANAGEMENT INTELLIGENCE MODEL

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As the all-hazards approach takes hold in our national Emergency Management and Homeland Security efforts and continues to seek greater collaboration between these two fields, an area that has yet to be explored to its fullest extent is the utilization of an intelligence process to enhance EM operations. Despite the existence of multiple Federal-level policies that outline the importance of intelligence and information sharing across the all-hazards community, EM is still, by and large, an outsider to the Intelligence Community (IC); the problem is one of both policy and of practice. Formalizing both an intelligence process and EM role culled from best practices of the FBI, U.S. Military, and local law enforcement, and subsequently equipping and training emergency managers in the use of intelligence, would be substantially beneficial in all phases of a disaster. Once established, an intelligence process could also help EM augment and integrate into the IC to provide more robust HS capabilities, including a significant role in the State/Local Fusion Centers. This formalized EM Intelligence Cycle (EMIC)

lays the groundwork for better EM-IC collaboration, better support to first responders during large-scale events, a more proactive role in preventing future disasters, and a more robust all-hazards community as a whole. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37714

Keywords: emergency management,iIntelligence, intelligence cycle, all-hazards, intelligence preparation of the battlespace, intelligence-led policing, natural disasters, state/local fusion centers

INSTILLING A CULTURE OF ACCOUNTABILITY AT THE DEPARTMENT OF HOMELAND SECURITY (DHS): LEVERAGING THE GOVERNMENT PERFORMANCE AND RESULTS MODERNIZATION ACT (GPRA-MA) OF 2010

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Linking the theoretical conceptualization of public and organizational accountability, defined as a culture of high trust, with the Government Performance and Results Modernization Act (GPRA-MA) of 2010, may revolutionize the way Department of Homeland Security (DHS) leaders and performance practitioners, partners and stakeholders consider and apply strategic performance management practices and processes within the department. This thesis contains twelve recommendations based on the concept of meta-governance, which incorporates relational webs and network power involving the general public, into departmental performance management and improvement processes. Our next generation solution to creatively implement the GPRA-MA, innovative (democratic) networked governance, integrates social complexity theory epistemologies and best practice principles in an attempt to ameliorate the five cultural conditions identified as contributing to deficiencies within the five major focus areas of the GPRA-MA. Placing organizational management, strategic planning, program evaluation, performance measurement, governance, accountability and decision making within the larger context of fiscal, ethical and democratic responsibility and responsiveness would be an inestimable force multiplier to both DHS politically appointed and career officials, having the potential to revolutionize the way the United States secures and protects its homeland. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37720

Keywords: Government Performance and Results Act, GPRA, accountability, performance management, performance management framework, performance improvement, performance measurement, performance reviews, strategic planning, decision-making, data analysis, program evaluation, transparency, meta-governance, social complexity theory

CREATING A BETTER END GAME STRATEGY: FULLY EXPLOITING THE CAPABILITIES OF MULTIPLE DISCIPLINES

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The United States' strategy to combat the terrorism threat has been widely debated since the attacks on 9/11. These attacks spurred many opinions on the best method to counter terrorism, whether through the military, law enforcement, intelligence, or diplomacy. The U.S. Intelligence Community has highly motivated agencies with specialized tools and techniques, which have been effectively used to thwart terrorist plots and engage in offensive actions. Unfortunately, there is no singular answer to terrorism. It requires the assimilation and stra-

tegic usage of these disciplines to be successful. The U.S. government must advance beyond mere coordination, as it is not the optimal standard. Collaboration is the defining difference to achieve the best strategic advantage. An analysis of the best practices identified in business and government to form cohesion within a unit will be conducted and compared to the current structures within the Intelligence Community. The strengths and limitations of existing units are carefully analyzed, and a model is proposed and examined using the same methodology. This research suggests that, through a highly collaborative unit engaging all the relevant disciplines, the United States can move toward a more effective strategy to counter the terrorist threat. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37722

Keywords: Joint Terrorism Task Force, collaboration, multi-discipline, intelligence, counterterrorism

INTERGOVERNMENTAL UNITY OF EFFORT IN SUPPORT OF BIOLOGICAL THREAT PREVENTION

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The purpose of this thesis is to examine ways to prevent the terrorist use of a biological weapon of mass destruction. Intelligence sources from around the globe report that terrorist groups are developing the capability and the intention to deliver biological weapons of mass destruction. Four coalitions of governments were studied to examine stated health security policies and reported outcome of a large biological threat incident of H1N1 global pandemic influenza of 2009–2010. This thesis presented the results and proposed methods to enhance intergovernmental connectivity and information sharing to prevent a biological threat. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37724

Keywords: biological weapon of mass destruction, U.S. Tribal Nations, H1N1, global pandemic influenza, health security policies, Global Health Security Initiative, GHSI, medical intelligence

TOWARD A COMMON STANDARD: THE ROLE OF LAW ENFORCEMENT AT WMD INCIDENTS

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Second Reader: Richard Bergin, Department of Information Sciences

This thesis examines the role of law enforcement personnel at weapons of mass destruction (WMD) and hazardous materials incidents with regard to WMD training, standards and preparedness, and identifies gaps and problems in current local law enforcement WMD response preparedness. Different models of local law enforcement WMD response are analyzed to compare with the New York City model, and the U.S. Bomb Squad and United Kingdom law enforcement chemical/biological/radiological/nuclear training programs are examined as examples of successful national preparedness response programs. The implications of this thesis indicate a need for a national strategy for local law enforcement WMD training, equipment and operating procedures to better coordinate response efforts between local law enforcement agencies at WMD incidents. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37728

Keywords: local law enforcement, WMD response, National Strategy for Law Enforcement, preparedness for WMD incidents, New York City Police Department

TURKISH INFLUENCE IN THE SOUTH CAUCASUS AND LEVANT: THE CONSEQUENCES FOR NATO AND THE EU

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Master of Arts in Security Studies (Europe and Eurasia)
Advisor: Donald Abenheim, Department of National Security Affairs
Co-Advisor: Victoria Clement, Department of National Security Affairs

This thesis examines Turkey's growth as a power under the Justice and Development Party (Adalet ve Kalkinma Partisi; AKP) government, and the implications for European institutions. In particular, this study reflects on the intertwined historical connection between Turkey and Europe in the South Caucasus and Levant; examines the extent to which Turkey's interest and policies under the AKP and European Union (EU)- North Atlantic Treaty Organization (NATO) interest and policies intersect and diverge in the two regions; and evaluates the implications and avenues for cooperation in areas of common interest. The analysis and assessment shows that Turkey's policies in the South Caucasus dovetail with EU-NATO regional interest and are not politically Islamic but pragmatic in nature. In the Levant, as in the South Caucasus, the AKP's interest and policies are somewhat aligned with those of EU-NATO; however, the region's volatility and Turkey's cultural and religious linkages to the Middle East are an added dimension which shapes the AKP's independent foreign policy trajectory. Additionally, realpolitik, not Islamism, rules the AKP's interaction with both state and non-state regional political actors. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37733

Keywords: Turkey, foreign policy, Justice and Development Party, Adalet ve Kalkinma Partisi, AKP, European Union, EU, North Atlantic Treaty Organization, NATO, South Caucasus, Levant

FROM DENIAL TO PARTICIPATION: TURKEY'S EVOLVING DISCOURSE ON KURDISH NATIONALISM

Scott Timmester–Lieutenant Commander, United States Navy
Master of Arts in Security Studies (Middle East, South Asia, Sub-Saharan Africa)
Advisor: Ryan Gingeras, Department of National Security Affairs
Second Reader: Maria Rasmussen, Department of National Security Affairs

Kurdish nationalism has been a central issue in domestic Turkish politics since the founding of the republic nearly a century ago. Since 1984, the insurgency waged by the Kurdistan Workers Party (PKK) has claimed the lives of over 40,000 citizens on both sides of the conflict. While Ankara has largely attempted to address the Kurdish question via military and security measures, unprecedented negotiations in the last year have raised hopes that a peace settlement may finally be within reach. While some observers are fearful that this round of talks will be yet another failed attempt to end the violence, this thesis seeks to explore whether recent changes in Turkey's social and political landscape have increased the likelihood of a lasting resolution. The research is framed as a historical survey of critical political events and public discourse from prominent politicians and public figures, relying on a mix of primary and secondary sources. This thesis argues that three domestic shifts have indeed helped set the stage for a lasting solution: increased political opportunities for Kurdish activists, the end of military tutelage in security affairs, and the reframing of Turkish nationalism through the assertion of Ottoman-Islamic identity. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37734

Keywords: Turkey, Republic of Turkey, Kurdish, Kurdistan Workers Party, PKK, terrorism, Islam, civil-military relations, Neo-Ottoman, AKP, nationalism, ethno-nationalism

A PRACTITIONER'S GUIDE TO TRUST AND LEGITIMACY

Patrick Walsh–Captain, Portland (Oregon) Police Bureau
Master of Arts in Security Studies (Homeland Security and Defense)
Advisor: Christopher Bellavita, Department of National Security Affairs
Second Reader: Rodrigo Nieto-Gomez, Department of National Security Affairs

The policing profession has evolved since the formalization of police forces in the late 1820s. Much of the change revolves around the community taking an interest in how the police conduct themselves and how they interact with the public. As the public demands more from the police, the police need to strive to gain trust and remain legitimate. This is easier said than done. Due to the breakdown in the social safety net, more and more police officers are called upon to assist those who are suffering from a mental illness. This intersection often tragically results in officers using force, or deadly force on these individuals. When this happens, many in the community lose faith in the police and trust is weakened or lost. In this paper, trust and legitimacy between the community and the police is examined. The argument is made that the police need to have trust and legitimacy with the public they serve in order to be effective in fighting crime as well as terrorism. Three aspects are examined that have the potential to build trust: The U.S. Department of Justice (DOJ) civil rights investigation of law enforcement, the strategic production of press releases, and the creation and use of a mobile smart phone application as a means of connecting to the community. By abiding with the DOJ recommendations, thinking strategically about the production of press releases, and leveraging technology to build relationships, it is argued that law enforcement can build trust and legitimacy. With trust and legitimacy, the public will assist, cooperate with, and obey the police. This relationship and collaboration is vital if law enforcement is to be successful in maintaining public safety and prevent terrorism. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37737

Keywords: trust, legitimacy, procedural justice, Department of Justice, DOJ, transparency, community engagement, Portland Police Bureau, social media, mobile phone app, public safety

COMMUNITY HAZARD VULNERABILITY ASSESSMENTS: HOW TECHNOLOGY CAN ASSIST IN COMPREHENSION

John Waters–Chief Fire Marshal, Upper Marion Township, Pennsylvania
Master of Arts in Security Studies (Homeland Security and Defense)
Advisor: Lauren Fernandez, Center for Homeland Defense and Security
Second Reader: Richard Bergin, Department of Information Sciences

The Federal Disaster Mitigation Act of 2000 mandates that all levels of government identify, classify and develop plans for the mitigation of the hazards to which they are exposed, be they natural or man-made. In addition to the legal requirement, communities need to complete a hazard vulnerability assessment to help them determine priorities in deciding how much of a given resource should be aimed at solving a given problem. No communities have unlimited resources; as such, it is imperative that resource allocators, be they emergency managers or elected officials, fully understand the depth and breadth of the multitude of hazards that their communities face. Understanding how humans process information and then using technology to assist in the comprehension of that information can only enhance a community's emergency management cycle of planning, mitigation, preparedness, response, and recovery. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37739

Keywords: learning styles, geographic information systems, hazard vulnerability, CAMEO, HAZUS

PRIVATIZATION OF PEACEKEEPING: UN'S INSTITUTIONAL CAPACITY TO CONTROL PRIVATE MILITARY AND SECURITY COMPANIES

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Master of Arts in Security Studies (Stabilization and Reconstruction)
Advisor: Anne Baylouny, Department of National Security Affairs
Co-Advisor: Sophal Ear, Department of National Security Affairs

Private Military and Security Companies (PMSCs) are perceived as a cost-effective alternative to the national troops contributed by member states to United Nations (UN) peacekeeping operations. This thesis draws on Thomas Bruneau's three-dimensional civil-military relations theory to answer the question: Can the United Nations employ PMSCs in peacekeeping operations to achieve UN goals more fully than national militaries? Analysis of the UN peacekeeping system reveals that, although the UN peacekeeping system has undergone several reforms and developed capacities, the current structure and institutional power of the UN has serious shortcomings in controlling PMSCs and ensuring effectiveness and efficiency. The UN needs to develop a more detailed doctrine, create an overarching institutional coordination mechanism, and enhance its logistics capacity to effectively employ PMSCs. Moreover, loose chain of command structures and vague exit strategies complicate the use of PMSCs in peacekeeping. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37747

Keywords: private military and security companies, United Nations, peacekeeping, privatization, institutional capacity, control, oversight, civil-military relations.

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MASTER OF BUSINESS ADMINISTRATION

ANALYSIS, DESIGN AND IMPLEMENTATION OF A PROOF-OF-CONCEPT PROTOTYPE TO SUPPORT LARGE-SCALE MILITARY EXPERIMENTATION

This thesis has been recognized as outstanding by its department.

Eid Alqhatani–Lieutenant Commander, Royal Saudi Naval Forces
Fahad Huwaymil–Lieutenant Commander, Royal Saudi Naval Forces
Master of Business Administration
Master of Science in Information Technology Management
Advisor: Magdi Kamel, Department of Information Sciences
Co-Advisor: Walter Kendall, Department of Information Sciences
Second Reader: Douglas Brinkley, Graduate School of Business and Public Policy

FORCEnet Innovation and Research Enterprise (FIRE) is an enterprise computer-based solution developed to support large-scale experimentation in the Navy and Department of Defense. Every year, experiments are conducted such as Trident Warrior (TW) events to assess new capabilities developed to achieve FORCEnet concept. FIRE is also used to support experimentation in other projects and for other services. FIRE was built by the Naval Postgraduate School to provide the necessary tools for the coordination of the planning, execution and reporting of these experiments. Since its inception in 2003, FIRE has played an essential role in TW by empowering all stakeholders with the collaborative and management tools to perform tasks that were time-consuming and manpower-intensive in the past. However, a survey conducted a few years ago showed that FIRE lacks some required features and improvement in various areas needed to be considered. The objective of this thesis was to design, develop, and test a proof-of-concept prototype of an improved web-based application to support the coordination of large-scale experimentation to address the shortcomings of the old FIRE system. This was achieved by using the following: a modern design approach, the Model-View-Controller, a state-of-the-art framework, Oracle Application Development Framework, and powerful development tools such as Oracle JDeveloper and Oracle WebCenter. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37579

Keywords: FORCEnet, FORCEnet Innovation and Research Enterprise, FIRE, web-based application, Oracle Application Development Framework, Oracle ADF, Trident Warrior, experiment, model-view-controller, MVC

USING SOCIAL MEDIA TOOLS TO ENHANCE TACIT KNOWLEDGE SHARING WITHIN THE USMC

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Master of Business Administration
Master of Science in Information Technology Management
Advisor: Mark Nissen, Department of Information Sciences
Co-Advisor: Cary Simon, Graduate School of Business and Public Policy

Social media usage has exploded over the past several years. Individuals are using social media tools to stay constantly connected to friends, family and co-workers. Companies have learned to leverage these same technologies both externally and internally. These emerging social technologies, applications and

platforms are an excellent way for geographically separated people to connect, communicate and share knowledge in novel ways. The United States Marine Corps (USMC) continues to communicate primarily through telephone, email and reports. The valuable resource of tacit knowledge contained within veterans of operations spanning from distributed counterinsurgencies to complex humanitarian assistance efforts is usually shared via face-to-face interaction and informal networks. Academic literature and industry adoption indicate that social media tools are now familiar and mature enough to provide an additional or even substitute conduit for this type of rich tacit knowledge sharing. How can social media tools be used to improve USMC tacit knowledge sharing? This research explores the extant use of Web 2.0-enabled social tools for the purpose of tacit knowledge sharing. A case study of a USMC unit identifies knowledge sharing pathologies and presents use cases for the application of social tools to address these pathologies. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37670

Keywords: social media, social networking, Web 2.0, knowledge management, tacit knowledge, knowledge sharing, knowledge flows, knowledge transfer, organizational learning

MASTER OF SCIENCE

Applied Cyber Operations
Applied Mathematics
Applied Physics
Astronautical Engineering
Computer Science
Contract Management
Cyber Systems and Operations
Electrical Engineering
Electronic Warfare Systems Engineering
Engineering Acoustics
Engineering Science
Human Systems Integration
Information Technology Management
Information Warfare Systems Engineering
Mechanical Engineering
Meteorology and Physical Oceanography
Modeling, Virtual Environments, and Simulation
Operations Research
Physical Oceanography
Program Management
Remote Sensing Intelligence
Space Systems Operations
Systems Engineering & Systems Engineering Management

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MASTER OF SCIENCE IN APPLIED CYBER OPERATIONS

BIG DATA ANALYTICS TEST BED

Rachel Doucet–Chief Petty Officer, United States Navy
Deyan Dontchev–Chief Petty Officer, United States Navy
Javon Burden–Chief Petty Officer, United States Navy
Thomas Skoff–Petty Officer First Class, United States Navy
Master of Science in Applied Cyber Operations
Advisor: Mark Gondree, Department of Computer Science
Co-Advisor: Thuy Nguyen, Department of Computer Science

The proliferation of big data has significantly expanded the quantity and breadth of information throughout the Department of Defense. The task of processing and analyzing this data has become difficult, if not infeasible, using traditional relational databases. The Navy has a growing priority for information processing, exploitation, and dissemination, which makes use of the vast network of sensors that produce a large amount of big data. This capstone report explores the feasibility of a scalable Tactical Cloud architecture that will harness and utilize the underlying open-source tools for big data analytics. A virtualized cloud environment was built and analyzed at the Naval Postgraduate School, which offers a test bed suitable for studying novel variations of these architectures. Further, the technologies directly used to implement the test bed seek to demonstrate a sustainable methodology for rapidly configuring and deploying virtualized machines and provides an environment for performance benchmark and testing. The capstone findings indicate the strategies and best practices to automate the deployment, provisioning and management of big data clusters. The functionality we seek to support is a far more general goal: finding open-source tools that help to deploy and configure large clusters for on-demand big data analytics. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37615

Keywords: big data, Hadoop, Serengeti, cloud computing, virtualization, virtual technology, multi-level security, VMware, vSphere 5.1, ESXi, Virtualized Hadoop

TEST AND EVALUATION OF THE MALICIOUS ACTIVITY SIMULATION TOOL (MAST) IN A LOCAL AREA NETWORK (LAN) RUNNING THE COMMON PC OPERATING SYSTEM ENVIRONMENT (COMPOSE)

Aaron Littlejohn–Lieutenant Commander, United States Navy
Ehab Makhlouf–Lieutenant, United States Navy
Master of Science in Applied Cyber Operations
Advisor: Gurminder Singh, Department of Computer Science
Second Reader: Arijit Das, Department of Computer Science

In the Department of the Navy's layered defense approach to protecting a computer network, it is the network administrators who provide the last layer of defense before the end user. Training network administrators is a rather expensive and time-consuming process. However, this training needs to be provided on a regular basis in order to refresh their readiness and to train them to respond to new, emerging threats. Malicious Activity Simulation Tool (MAST) aims to provide realistic, tailored simulation of malicious activity for the purpose of training network administrators to recognize and respond to threats on the network

they manage. In a continuation of MAST development, this thesis reports the testing and evaluation of the MAST functionality on a Local Area Network (LAN) using a Common PC Operating System Environment (COMPOSE) as its network operating system. We conclude that MAST can present realistic simulations of malicious activity that could be detected, recognized, and responded to by network administrators and a host network while posing no threat to the operational readiness of the host network or its supported missions. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37663

Keywords: defense, simulation, network administrator training, cyberspace, cyber domain, cyber test range

MASTER OF SCIENCE IN APPLIED MATHEMATICS

PSEUDORANDOM NUMBER GENERATORS FOR MOBILE DEVICES: AN EXAMINATION AND ATTEMPT TO IMPROVE RANDOMNESS

This thesis has been recognized as outstanding by its department.

Ola Larsson–Major, Swedish Army
Master of Science in Applied Mathematics
Master of Science in Information Warfare Systems Engineering
Advisor: Pantelimon Stanica, Department of Applied Mathematics
Co-Advisor: Zachary Peterson, Department of Computer Science
Second Reader: Raymond Buettner, Department of Information Sciences

This thesis examines the quality of pseudorandom number generation for cryptographic purposes in general and the generation of such numbers in a mobile device (Android phone), in particular, since we expected to find non-random properties in these. Initially, the need for random numbers for encryption purposes is discussed from a perspective of Information Warfare. Thereafter, ways of testing a bit string for random properties as well as some pseudorandom number generating algorithms are presented. This also includes the shrinking and the self-shrinking generator normally used to improve the random properties of the output m-sequence of linear feedback shift registers. A couple of possible attacks on pseudorandom number generators are also briefly presented. Finally, we generate and analyze some pseudorandom bit strings in three different ways using the NIST test suite, both before and after the self-shrinking generator has been applied to them. The strings generated by the Android phone passed the NIST test suite, and it is difficult to claim any improvement in random properties by applying the self-shrinking generator. On a bit string with poor random properties, however, the self-shrinking generator improves randomness from the perspective of linear dependency and complexity, but not from the perspective of bit frequency. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37657

Keywords: pseudorandom number generator, PRNG, random number, random bit, self-shrinking generator, SSG, encryption, mobile device, Android

TOWARD LARGE-GRAPH COMPARISON MEASURES TO UNDERSTAND INTERNET TOPOLOGY DYNAMICS

This thesis has been recognized as outstanding by its department.

Hsu Ann Daryl Lee–Civilian, Singapore Technologies Electronics (Info-Software Systems)
Master of Science in Applied Mathematics
Advisor: Ralucca Gera, Department of Applied Mathematics
Second Reader: Robert Beverly, Department of Computer Science

By measuring network changes, we can get a better understanding of a network. Extending this to the Internet, we are able to understand the constantly occuring changes on an international scale. In this research, we propose a measure that conveys the relative magnitude of the change between two networks (i.e., Internet topology). The measure is normalized and intuitively gives an indication of whether the change is small or large. We start off by applying this measure to standard common graphs, as well as random graphs. These graphs were first simulated and the measurements taken; results were then proved theoretically. These corresponded to the simulation results, thus demonstrating correctness. For case studies, we

compared actual implemented networks with that which is inferred by probes. This comparison was done to study how accurate the probes were in discovering actual network topology. Finally, we conducted real-world experiments by applying the measurements to certain segments of the Internet. We observed that the measurements do indeed pick up events that significantly influenced structural changes to the Internet. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37658

Keywords: distance, dissimilarity between graphs, symmetric difference, internet topology, Egypt/Libya revolution

MASTER OF SCIENCE IN APPLIED PHYSICS

SUPER-RADIANT FREE ELECTRON LASER MEASUREMENT AND DETECTION

Conor Michael Pogue–Civilian, Naval Postgraduate School
Master of Science in Applied Physics
Advisor: William Colson, Department of Physics
Co-Advisor: Keith Cohn, Department of Physics
Second Reader: Joe Blau, Department of Physics

A free electron laser (FEL) is a type of laser that uses relativistic electron bunches and a periodic magnetic field to generate coherent radiation. These types of lasers are of interest to the Navy because they can operate at high average power with excellent optical beam quality, which is needed in many military applications. A current project between the U.S. Navy and Niowave Inc. is to create a super-radiant FEL that uses superconducting spoke cavities for the electron accelerating structures. These types of cavities have never been used in an FEL before and may be more suitable for deployment on naval platforms due to their small size and structural rigidity compared to more conventional cavities. Furthermore, spoke cavities allow operation at lower accelerating frequencies while still maintaining reasonable size cavities, which may reduce power requirements for the cryoplant. This thesis will discuss a variety of optical transport and detection arrangements for various setups and FEL operational regimes. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37696

Keywords: free electron laser, THz, terahertz, optical transport, detection

CHARACTERIZATION OF TERAHERTZ BI-MATERIAL SENSORS WITH INTEGRATED METAMATERIAL ABSORBERS

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Advisor: Gamani Karunasiri, Department of Physics
Co-Advisor: Fabio Alves, Department of Physics

THz radiation covers the region of the electro-magnetic (EM) spectrum between the microwaves and infra-red (IR), corresponding to frequencies from approximately 100 GHz to 10 THz. Recently, new imaging techniques, which take advantage of the special properties of THz waves, have been developed. Despite the great interest in these new techniques, limitations such as the lack of appropriate detectors and powerful sources are placing the technology in the research domain. The objective of this thesis is to characterize and analyze a set of fabricated bi-material detectors integrated with thin metamaterial films. Different experimental measurements were performed to measure the main figures of merit of the detectors and analyze them. Initially, optical microscopy was used to measure the dimensions of the sensors and stress induced curvature. Then, the thermal response of the sensors was tested and analyzed. The responsivity, the speed of operation and the minimum detected incident power were measured using a quantum cascade laser (QCL), operating at 3.8 THz. The measured experimental data agree well with the theoretical calculated values of the performance parameters. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37711

Keywords: terahertz imaging, bi-material sensors, metamaterial films, responsivity. thermomechanical sensitivity, speed of operation, NEP

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MASTER OF SCIENCE IN ASTRONAUTICAL ENGINEERING

INCREASING SLEW PERFORMANCE OF REACTION WHEEL ATTITUDE CONTROL SYSTEMS

This thesis has been recognized as outstanding by its department.

Steven Crews II–Major, United States Army
Master of Science in Astronautical Engineering
Master of Science in Mechanical Engineering
Advisor: Mark Karpenko, Department of Mechanical and Aerospace Engineering
Co-Advisor: Isaac Ross, Department of Mechanical and Aerospace Engineering

This thesis explores the physical and mathematical limitations of two common attitude control systems: one based on reaction wheels and another based on control moment gyroscopes (CMGs). The dynamics are derived from first principles, and control algorithms for achieving maximum reaction wheel potential are discussed. The shaped eigenaxis input is utilized to establish baseline maneuver performance. A time-optimal shaped input is introduced and implemented in a feedback setting, subject to the limitations of the Moore-Penrose pseudo-inverse control allocation. Finally, a feed-forward plus feedback controller is introduced to implement the time-optimal torque inputs directly to the reaction wheels. This obviates the need for the pseudo-inverse control allocation, and therefore exploits the total capacities of both the reaction wheel momentum envelope and torque envelope. These reaction wheel control approaches are compared with CMG performance to establish spacecraft size and slew parameters that make the use of reaction wheels a reasonable choice. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37606

Keywords: reaction wheel, control moment gyroscope, CMG, momentum envelope, torque envelope, optimization, optimal control, pseudo-inverse, DIDO, scaling, effective eigenaxis, reaction wheel advantage angle

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MASTER OF SCIENCE IN COMPUTER SCIENCE

EFFICIENT STRATEGIES FOR ACTIVE INTERFACE-LEVEL NETWORK TOPOLOGY DISCOVERY

Guillermo Baltra–Lieutenant, Chilean Navy
Master of Science in Computer Science and Electrical Engineering
Advisor: Preetha Thulasiraman, Department of Electrical and Computer Engineering
Co-Advisor: Robert Beverly, Department of Computer Science

As a piece of critical infrastructure, the Internet brings both benefits and security concerns. Recent cybersecurity episodes such as route hijacks and denial-of-service attacks might have been mitigated and prevented with better knowledge of the network' s logical topology—i.e., router nodes and links. Current production public active mapping systems—e.g., Ark, Rocketfuel, and iPlane—produce valuable inferences of the Internet' s topology, as well as facilitating longitudinal analysis. We examine the extent to which the techniques utilized by these existing systems can be improved—in particular, by attempting to reduce their high probing load. Our methodology divides the discovery process into three steps: destination selection, monitor assignment, and stop criterion. We implement and evaluate alternative designs for each step. The complete system runs in real time on a production system to probe 500 randomly selected Internet subnetworks and gather real-world network maps. As compared to datasets from existing measurement platforms, we find that our method is able to generate 80% of the amount of data with 69% less load. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37583

Keywords: internet topology, network topology, adaptive probing

MACHINE LEARNING FEATURE SELECTION FOR TUNING MEMORY PAGE SWAPPING

Rick Battle–Lieutenant, United States Navy
Master of Science in Computer Science
Advisor: Craig Martell, Department of Computer Science
Second Reader: Joel Young, Department of Computer Science

This thesis is an exploration of the virtual memory subsystem in the modern Linux kernel. It applies machine learning to find areas where better page-out decisions can be made. Two areas of possible improvement are identified and analyzed. The first area explored arises because pages in a computation appear repeatedly in a sequence. This is an example of temporal locality. In this instance, we can predict pages that will not be recalled again from the backing store with a precision and recall of 0.82 and 0.81, respectively, with a baseline of 0.30. The second is trying to predict when the system has made bad page-out decisions, those which lived in the backing store for less than one second before being recalled into RAM. In this case, we achieved a precision of 0.82 and a recall of 0.81 with a baseline of 0.12. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37585

Keywords: Linux Kernel, virtual memory, machine learning, temporal locality

UNSUPERVISED TOPIC DISCOVERY BY ANOMALY DETECTION

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Master of Science in Computer Science
Advisor: Craig Martell, Department of Computer Science
Co-Advisor: Pranav Anand, Department of Computer Science

With the vast amount of information and public comment available online, it is of increasing interest to understand what is being said and what topics are trending online. Government agencies, for example, want to know what policies concern the public without having to look through thousands of comments manually. Topic detection provides automatic identification of topics in documents based on the information content and enhances many natural language processing tasks, including text summarization and information retrieval. Unsupervised topic detection, however, has always been a difficult task. Methods such as Latent Dirichlet Allocation (LDA) convert documents from word space into document space (weighted sums over topic space), but do not perform any form of classification, nor do they address the relation of generated topics with actual human level topics. In this thesis we attempt a novel way of unsupervised topic detection and classification by performing LDA and then clustering. We propose variations to the popular K-Mean Clustering algorithm to optimize the choice of centroids, and we perform experiments using Facebook data and the New York Times (NYT) corpus. Although the results were poor for the Facebook data, our method performed acceptably with the NYT data. The new clustering algorithms also performed slightly and consistently better than the normal K-Means algorithm. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37599

Keywords: unsupervised topic detection, anomaly detection, K-means clustering, Latent Dirichlet Allocation

CURRICULUM MODULES IN SUPPORT OF TABLETOP CYBERSECURITY GAMES

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Master of Science in Computer Science
Advisor: Mark Gondree, Department of Computer Science
Co-Advisor: Zachary Peterson, Department of Computer Science

The number of bachelor degrees in computer science has continued to decline over the past decade. These trends similarly affect the cyber security sub-discipline of computer science. The non-digital computer security board game [d0x3d!] aims to teach cyber security concepts to a young, non-CS audience, to increase interest in the subject, and have a positive effect on computer science education. We develop curriculum modules in the form of lesson plans to complement this game. This demonstrates how the game can be used in an academic setting to scaffold instruction that introduces security concepts to K-12 audiences more formally. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37604

Keywords: cyber security education, lesson plans, digital assets, social engineering, hackers, non-digital computer security games, cyber security concepts

RAPID NETWORK DESIGN

Timmy Garcia–Captain, United States Marine Corps
Master of Science in Computer Science
Advisor: Geoffrey Xie, Department of Computer Science
Second Reader: Thomas Otani, Department of Computer Science

Network planning is a key element in the Marine Corps' communications planning process. The ability to design and provide reliable network architecture directly affects the commander's ability to control operations in an operational environment. Command-and-control systems technologies continue to change and evolve, adding complexity to network design. Portions of the current process of

designing packet-switched networks are extremely prone to human design faults, which can adversely affect the reliability of the network. This thesis proposes an application prototype for network design that automates the creation of network configuration files. It describes the benefits achievable for development of such an application. Lastly, we demonstrate a working prototype that successfully produced configurations files that can easily be uploaded to network devices and create a functioning packet-switch network. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37630

Keywords: network design, network topology, packet-switching networks, routing protocols, data communications, network communications

ENERGY EFFICIENT GROUP CONTEXT AWARE SENSOR MANAGEMENT STRATEGY FOR TACTICAL OPERATIONS

Samantha Graves–Captain, United States Marine Corps
Master of Science in Computer Science
Advisor: Gurminder Singh, Department of Computer Science
Co-Advisor: John Gibson, Department of Computer Science

Shared situational awareness (SSA) is essential to success and safety in tactical environments, whether fighting wars or providing relief during disasters and humanitarian catastrophes. The increased availability of sensors in mobile devices offers groundbreaking opportunities for continuous context-aware applications that are capable of responding to the operating conditions of users and their environment. However, continuous context-aware applications involve high-energy consumption. A key challenge in tactical environments is to make the most effective use of scarce resources. There are numerous approaches for reducing energy consumption of continuous context-aware applications. This thesis examines two methods: Sensor Substitution and Triggering (SENST) and Acquisitional Context Engine (ACE). The goal of this thesis is to explore the capabilities and limitations of SENST and ACE for group context-awareness and provide a group energy-efficient sensor management strategy that enhances the dissemination of SSA in tactical environments. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37633

Keywords: group context aware applications, sensor management, continuous context sensing, energy efficiency

TRIAGE VISUALIZATION FOR DIGITAL MEDIA EXPLOITATION

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Master of Science in Computer Science
Advisor: Simson Garfinkel, Department of Computer Science
Second Reader: Rudolph Darken, Department of Computer Science

Digital forensic examiners are overwhelmed by case loads and data volumes and must prioritize their work. This thesis hypothesis that digital forensic examiners can employ triage visualizations to prioritize workloads. This thesis presents a simple one-page visualization of disk activity for Windows FAT and NTFS filesystems. The visualization is constructed from filesystem metadata carved by the open source bulk-extractor digital forensics application. The visualization does not require further examination or reconstruction of file system metadata. The visualization is able to detect minor obfuscation or modification and overwriting of file system timestamps. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37636

Keywords: digital forensics, visualization, triage

APPLICATION OF ARCHITECTURAL PATTERNS AND LIGHTWEIGHT FORMAL METHOD FOR THE VALIDATION AND VERIFICATION OF SAFETY CRITICAL SYSTEMS

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Master of Science in Computer Science
Advisor: Man-Tak Shing, Department of Computer Science
Co-Advisor: James Michael, Department of Computer Science

This thesis researches the role of software architectural patterns and lightweight formal methods in safety-critical software development. We present a framework that relates the different activities and products from system engineering, safety engineering, system and software requirements, and software architecture explicitly, and demonstrate the proposed framework with a case study involving the architectural design of the software to control the arming device of a fictitious Surface-to-Air Missile. We describe the safety engineering steps for the identification of the system hazards and the critical functions that the software has to provide to avoid premature detonation, resulting in four safety requirements for the software that controls the missiles Electronic Safe Arm Device. We formalize the software safety requirements as statechart assertions and validate their correctness via JUnit test. We develop a software architecture for the control software using the Safety Executive pattern and implement the design in C++ to support a simple time-step simulation to produce the required log files for the automated verification of the design. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37646

Keywords: safety-critical and software intensive systems, software architecture, architectural patterns, software safety requirements, validation and verification,formal methods

CROSS-PLATFORM DEVELOPMENT TECHNIQUES FOR MOBILE DEVICES

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Second Reader: Loren Peitso, Department of Computer Science

Business and the military have become increasingly dependent on mobile technology in the last decade. The proliferation of mobile devices provides application developers with a new and growing market for providing solutions. Mobile devices run on diverse platforms requiring differing constraints that the developer must adhere to. Thus, extra time and resources must be expended to develop multiple versions of a single application for the different platforms. There have been attempts to minimize the need for these extra costs with mobile cross-platform development environments such as Titanium, PhoneGap, and Corona. They are relatively new to the mobile application building world, and though they have the same goal, their approaches are quite different. In this thesis, we will provide a detailed analysis of these three cross-platform development tools by using each to develop applications, then compare each by describing relative strengths and weaknesses. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37666

Keywords: mobile development, cross-platform development, Android development, iOS development

CREATING PROFILES FROM USER NETWORK BEHAVIOR

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The ability to identify network users based on their network behavior has both positive and negative implications. If users are tracked on the Internet without their knowledge or permission, this could be inter-

preted as a serious violation of their privacy. If used, however, as part of an organization's network security measures, the ability to identify and verify users might assist in determining whether one user is masquerading as a different user, or whether some user is exhibiting abnormal behavior that might precede malicious insider activity. As a step toward enhancing network security, we investigate the use of DNS hostnames and destination IPs for user identification, based on models of user behavior. Our results indicate that using DNS hostnames is a superior method of modeling user behavior. Additionally, when filtering the data for regular accesses, the accuracies improve for both DNS hostnames and destination IPs. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37673

Keywords: network behavior profiles, user identification

SOCIAL MEDIA SENTIMENT ANALYSIS AND TOPIC DETECTION FOR SINGAPORE ENGLISH

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Co-Advisor: Pranav Anand, Department of Computer Science

Social media has become an increasingly important part of our daily lives in the last few years. With the convenience built into smart devices, many new ways of communicating have been made possible via social-media applications. Sentiment analysis and topic detection are two growing areas in Natural Language Processing, and there are increasing trends of using them in social media analytics. In this thesis, we analyze various standard methods used in supervised sentiment analysis and supervised topic detection on social media for Colloquial Singapore English. For supervised topic detection, we created a naïve Bayes classifier that performed classification on 5,000 annotated Facebook posts. We compared the result of our classifier against open source classifiers such as Support Vector Machine (SVM), Maximum Entropy and Labeled Latent Dirichlet Allocation (LDA). For supervised sentiment analysis, we developed a phrasal classifier that analyzed the polarity of 425 argumentative Facebook posts. Our naïve Bayes classifier gave the best accuracy result of 89% for supervised topic detection on two-class classification and 57% accuracy for our six-class classification. For our supervised sentiment analysis, our phrasal sentiment analysis classifier obtained an accuracy of 35.5% with negative polarity class achieving a high precision of 94.3%. See full thesis text: https://calhoun.nps.edu/public/handle/10945/38272

Keywords: machine learning, topic detection, sentiment analysis, Singapore English, Naive Bayes Classifier

SECURE MILITARY COMMUNICATIONS ON 3G, 4G AND WIMAX

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Advisor: Gurminder Singh, Department of Computer Science
Co-Advisor: John Gibson, Department of Computer Science

Today, wireless communications offer great convenience and efficiency, but concerns about security must be addressed. Wireless communications are considered less secure than wired or fiber-based systems because the data is transmitted over the radio channel, making it more susceptible to eavesdropping and interception. Thus, security needs special attention. Confidentiality, integrity and availability are the objectives of security solutions. Attacks such as Man-in-the-Middle, replay, and Denial-of-Service are mitigated or eliminated by solutions such as those discussed in this thesis. Data disclosure to unauthorized people, user identity and location disclosure, impersonation of a valid user, user tracking, and subscriber capabilities disclosure are a few of the potential risks that can lead to a mission failure and even cost people's lives. This thesis explores how to securely leverage three cellular technologies (3G, 4G/LTE and WiMAX) through an analysis of their security features. The security architec-

tures of these wireless technologies are described. Their security vulnerabilities and the potential attack vectors are analyzed. A few protocols and techniques that address or mitigate the security deficiencies and the way they enforce security are provided. Furthermore, the importance of security in military communications is considered. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37712

Keywords: 3G, 4G, LTE, WiMAX, wireless security, wireless communications, military communications

FINGERPRINTING REVERSE PROXIES USING TIMING ANALYSIS OF TCP FLOWS

This thesis has been recognized as outstanding by its department.

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Co-Advisor: Robert Beverly, Department of Computer Science
Second Reader: Justin Rohrer, Department of Computer Science

Reverse proxy servers are valuable assets to defend outside hosts from seeing the internal network structure upon which the reverse proxy is serving. They are frequently used to protect valuable files, systems, and internal users from external users while still providing services to outside hosts. Another aspect of reverse proxies is that they can be installed remotely by malicious actors onto compromised machines in order to service malicious content while masking where the content is truly hosted. Reverse proxies interact over the HyperText Transfer Protocol (HTTP), which is delivered via the Transmission Control Protocol (TCP). TCP flows provide various details regarding connections between an end host and a server. One such detail is the timestamp of each packet delivery. Concurrent timestamps may be used to calculate round trip times with some scrutiny. Previous work in timing analysis suggests that active HTTP probes to servers can be analyzed at the originating host in order to classify servers as reverse proxies or otherwise. We collect TCP session data from a variety of global vantage points, actively probing a list of servers with a goal of developing an effective classifier to discern whether each server is a reverse proxy or not based on the timing of packet round trip times. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37740

Keywords: active measurement, timing analysis, reverse proxy, fingerprinting

EMPLOYING REPLAY CONNECTORS FOR SIEM OPERATOR EDUCATION

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Co-Advisor: John Krautheim, Cyber Academic Group

Security Information and Event Management (SIEM) solutions are a critical information systems security control for monitoring, assessing, and reacting to cyber threats in near real time. A given SIEM solution, however, is not a simple plug-and-play, drop-in, security device. On the contrary, a successful implementation requires configuration tailored to the specifics of a target network, as well as operators who are very knowledgeable of both the SIEM's functionality and the characteristics of network/data-center events. This thesis will lay the framework for SIEM operator education via use of pre-captured network/data-center events (i.e., network traffic and device log information). The desired outcome is a repeatable framework that can be utilized by organizations interested in deploying more technically savvy SIEM operators. The framework will be empirically demonstrated with a SIEM learning lab developed for HPs ArcSight SIEM. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37745

Keywords: security information and event management, SIEM, correlation, rule, filter, aggregate

CYBER-SECURITY CURRICULA FOR BASIC USERS

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Co-Advisor: Mark Gondree, Department of Computer Science

There have been only a small number of attempts at creating a cyber-security curriculum that can be used to teach children the concepts of cyber security and information assurance. There is a significant shortage of attempts at creating a computer-security curricula and cyber-security training for people who have only basic computer skills. Also, the integration of computer-security and information assurance principles into formal and accepted primary and secondary education is nearly nonexistent. Our research has been aimed at evaluating the current computer-security curricula according to widely accepted educational standards. The objective is to (1) create a set of requirements to analyze the effectiveness of computer-security curricula, (2) determine the best current disseminated cyber-security curriculum for children, and (3) make recommendations for a cyber-security curriculum by utilizing the best traits of the surveyed programs. Literature includes studies on previously created computer-security curricula and the most effective means of teaching children new concepts. Our research questions include: Is it important for a curriculum to be flexible enough to affect a variety of age groups? Is it important for a computer-security education to be interactive and motivational? Is it possible to teach difficult computer-security concepts in a way that children can understand? See full thesis text: https://calhoun.nps.edu/public/handle/10945/37750

Keywords: computer-security, cyber-security, education, curriculum, non-technical computer users, Internet safety

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MASTER OF SCIENCE IN CONTRACT MANAGEMENT

AN EMPIRICAL STUDY OF THE CONTRACTING OFFICER REPRESENTATIVES SOCIAL NETWORK

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Patrick Hamilton–Civilian, United States Army
Derrick Torgerson–Civilian, United States Army
Master of Science in Contract Management
Advisor: Janie Maddox, Graduate School of Business and Public Policy
Co-Advisor: Ralucca Gera, Department of Applied Mathematics

The volume and amount of money spent on services acquired by the Department of Defense, which include construction, has grown steadily over the past several fiscal years. Recent studies of services acquisition have shown not only the challenges in acquiring these services, but also how they are managed. One member that is intimately involved with the management of service and construction contracts is the contracting officer's representative (COR). The COR acts as the eyes and ears of the procuring contracting officer and is primarily responsible for monitoring the performance of the service by the contractor to ensure that they are meeting all requirements outlined in the contract or the work statement. The purpose of this study is to better understand the social network of the COR. The goal is to answer the following questions: (1) What is the structure of the COR's social network and what members are included in it? (2) How does communication transpire between each member of the network? (3) What conclusions can be drawn from the analysis of the social network? See full thesis text: https://calhoun.nps.edu/public/handle/10945/37581

Keywords: service contracts, services acquisition, contracting officers representative, contractor surveillance, social network

STRATEGIC SOURCING IN THE ARMY

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Co-Advisor: Jeffrey Pierce, Army Contracting Command

The objective of this project is to examine how the Army is utilizing strategic sourcing as an effective process for getting the best overall value for acquiring goods and services. An analysis will be done to determine if the Army is using Strategic Sourcing as intended by the Office of Management and Budget (OMB) initial implementation. This will be examined to determine if strategic sourcing will contribute to the efficiency of the acquisition process. Acquisitions will be examined to determine if strategic sourcing is meeting the needs of the organization and alleviating redundancy in the acquisition process. The discussions will also look at how important internal customer requirements and external marketplace intelligence roles are in the strategic sourcing process. As a result of this project, the Army will better understand the areas that may need improvement and areas that have been working effectively. Future recommendations for research will be provided for consideration. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37628

Keywords: strategic sourcing

COMPARISON OF THE DEPARTMENT OF THE ARMY, NAVY AND AIR FORCE'S CONTRACTING INTERNSHIP PROGRAMS

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Co-Advisor: Regina Roberts

The Department of Defense has experienced a significant loss of acquisition professionals because of attrition and workforce reductions. Interns have been hired to curtail the loss, but the dwindling number of experienced acquisition personnel has left little time to train the new entrants while still meeting complex mission requirements. In an effort to maintain a professional staff that is qualified to fill critical positions in contracting, the Air Force, Army, and Navy have each created contracting internship programs. The research purpose is to: (1) identify whether the DoD contracting competencies are covered consistently among the Army, Navy, and Air Force's contracting internship programs, (2) determine if and to what extent these defense organizations are incorporating industry best practices into their internship programs, and (3) recommend program improvements to ensure consistent coverage of the DoD contracting competencies and that industry best practices are incorporated. Study results suggest that the defense contracting internship programs are not consistent in their coverage of DoD contracting competencies and that each program has best practices that are not fully implemented. Alignment and standardization of the defense internship programs are suggested to ensure consistent coverage of DoD contracting technical competencies and that industry best practices be fully incorporated. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37680

Keywords: defense contracting internships, contracting competencies, acquisition workforce competencies, consistencies and trends

PRICE ANALYSIS ON COMMERCIAL ITEM PURCHASES WITHIN THE DEPARTMENT OF DEFENSE

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Erik Nelson–Civilian, Department of the Army
Matthew White–Civilian, Department of the Army
Master of Science in Contract Management
Advisor: Janie Maddox, Graduate School of Business and Public Policy
Co-Advisor: Ralucca Gera, Department of Applied Mathematics

Proficiency in completing price reasonableness determinations and documenting the contracting file properly is developed based on experience and completion of required contract pricing courses provided through the Defense Acquisition Workforce Improvement Act certification process. As there is a wide range of skill levels within the contracting community, it is possible that employees surveyed may not have attended the required contracting pricing courses or developed the skills required to properly complete price reasonableness determinations. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37743

Keywords: contract pricing, price reasonableness, price analysis, commercial item purchases, fair and reasonable pricing

ANALYSIS OF THE UNITED STATES DEFENSE AND CIVILIAN CONTRACTING WORKFORCE'S TRAINING ON PROCUREMENT FRAUD, WASTE AND ABUSE

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Co-Advisor: Rhonda Labron, National Aeronautics and Space Administration

The objective of this project is to examine the current state of training of the contracting community on procurement fraud, waste and abuse (FW&A). This project also examines the need for and practical aspects of implementation for a contracting course on procurement FW&A into the procurement certification process. This research will look into the benefits of having a course implemented into the certification process as well as the feasibility of doing so. The expected product of this research is to provide a research paper that would enlighten the contracting community with greater insight to promote having a procurement FW&A course be part of the certification process. This would mean the incorporation of this course into the curriculum for Federal Acquisition Certification-Contracting and Defense Acquisition Workforce Improvement Act certification. The end goal of this research is to examine an alternative method that can assist in the reduction of FW&A and change the contracting profession as a whole on how it deals with FW&A. As a result of this project, the contracting community and profession will have a better understanding of whether implementing a procurement FW&A course is something feasible and executable. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37702

Keywords: fraud, waste, abuse, FW&A, training, FAC-C, procurement, contracting specialist, certification

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MASTER OF SCIENCE IN CYBER SYSTEMS AND OPERATIONS

AN INNOVATION FRAMEWORK APPLIED TO A MILITARY CYBER PROFESSIONALS ASSOCIATION

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Master of Science in Cyber Systems and Operations
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Second Reader: Susan Higgins, Department of Information Sciences

Be it on Wall Street, Main Street, or K Street, Americans are concerned about cyber threats, as cyberspace underpins national security and prosperity in the 21st century. The concern is expressed in dinner table discussions, governmental strategy documents, and blogs alike. A commonly held assertion is that current practices toward securing cyberspace are insufficient, necessitating innovative new approaches. In response to calls for such innovation by the Department of Defense, this work proposes a new organization designed specifically to address enduring national security priorities concerning cyberspace. In order to bring about such an organization and put it on a firm enough foundation to ensure sustaining endurance, a generative framework of innovation, the Innovators Way (IW), was applied. This endeavor meets the IW criteria of innovation, which is defined as the adoption of new practices within a community. In this case, the practice is a new professionals association and the community is the American military cyber workforce (a subset of the greater American defense community). This work is a culmination of a yearlong effort to employ and evaluate the IW framework, which emphasizes the role of adoption in the innovation process. The weight applied to adoption in this framework should resonate with those passionate about making things happen and helps to answer the so what? question commonly applied to good ideas. This case study serves as an evaluation of this generalizable framework, from which an enduring engine of national cyber development has been bequeathed. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37587

Keywords: cyber, cyberspace, cybersecurity, cyberwar, cyber conflict, cyber policy, joint, interdisciplinary, military cyber profession, professions, professional associations, military cyber professionals association, cyber command, innovation, innovation adoption, innovation model, nonprofit, entrepreneur, intrapreneur, extrapreneur, collective intelligence, social networks

SECURITY INFORMATION AND EVENT MANAGEMENT TOOLS AND INSIDER THREAT DETECTION

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Advisor: J.D. Fulp, Department of Computer Science
Co-Advisor: Frank Krautheim, Cyber Academic Group

Malicious insider activities on military networks can pose a threat to military operations. Early identification of malicious insiders assists in preventing significant damage and reduces the overall insider threat to military networks. Security Information and Event Management (SIEM) tools can be used to identify potential malicious insider activities. SIEM tools provide the ability to normalize and correlate log data from multiple sources on networks. Personnel background investigations and administrative action information can provide data sources for SIEM tools in order to assist in early identification of the insider threat by correlating this information with the individual's online activities. This thesis provides background information on the

components and functionality of SIEM tools, summarizes historic insider threat cases to determine common motivations, provides an overview of military security investigations and administrative actions in order to determine candidate sources for SIEM correlation, and provides an overview of common methods of data exfiltration by malicious insiders. This information is then used to develop an example SIEM architecture that highlights how the military can use a SIEM to identify and prevent potential internal insider threats by correlating an individual's network activities with background investigation and administrative action information. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37596

Keywords: insider threat, security information and event management, personnel security investigations

U.S. NATIONAL CYBERSTRATEGY AND CRITICAL INFRASTRUCTURE: THE PROTECTION MANDATE AND ITS EXECUTION

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Co-Advisor: Edward Fisher, Department of Information Sciences

The U.S has experienced numerous strategy assessments with respect to cybersecurity of the national critical infrastructure and key resources (CI/KR). This is primarily due to the recurring realization of, but failure to address, root issues creating a clear disparity between the strategic national requirements and DHS execution of its mandate regarding the reactionary protection of CI/KR. This thesis compiles (1) the current and past literature involving the evolution of critical infrastructure protection as it relates to cybersecurity; (2) how the current administration is addressing it; and (3) the various roles and authorities allocated to the various major executive agencies. This thesis concludes by providing eight specific recommendations with respect to improving the cybersecurity of the national CI/KR. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37703

Keywords: strategy, cyber, cyber-attack, cyber policy, cyber era, USCYBERCOM, US-CERT, national cyber strategy, national infrastructure protection plan, NIPP, critical infrastructure, CI, key resources, KR, CIKR, CI/KR, critical infrastructure protection, CIP

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

EFFICIENT STRATEGIES FOR ACTIVE INTERFACE-LEVEL NETWORK TOPOLOGY DISCOVERY

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Co-Advisor: Robert Beverly, Department of Computer Science

As a piece of critical infrastructure, the Internet brings both benefits and security concerns. Recent cybersecurity episodes such as route hijacks and denial-of-service attacks might have been mitigated and prevented with better knowledge of the network' s logical topology—i.e., router nodes and links. Current production public active mapping systems—e.g., Ark, Rocketfuel, and iPlane—produce valuable inferences of the Internet' s topology, as well as facilitating longitudinal analysis. We examine the extent to which the techniques utilized by these existing systems can be improved—in particular, by attempting to reduce their high probing load. Our methodology divides the discovery process into three steps: destination selection, monitor assignment, and stop criterion. We implement and evaluate alternative designs for each step. The complete system runs in real time on a production system to probe 500 randomly selected Internet subnetworks and gather real-world network maps. As compared to datasets from existing measurement platforms, we find that our method is able to generate 80% of the amount of data with 69% less load. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37583

Keywords: internet topology, network topology, adaptive probing

ULTRA LOW-VOLTAGE ENERGY HARVESTING

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Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

The U.S. Navy has many opportunities to take advantage of energy sources that are usually wasted because these low-power sources yield such low voltages that a normal voltage converter is not efficient enough to harvest the energy. Low-voltage energy is available in many forms, including solar, thermal, vibration, and electro-magnetic. The power that can be obtained from these sources on a small scale can be taken advantage of by using an ultra-low power boost converter that is specifically designed for energy harvesting applications. These energy sources with a very small footprint can be used in military and defense applications, such as wireless sensor networks, industrial monitoring, and varieties of portable and wearable devices. The theory of power conversion, synchronous rectification, and maximum power point tracking is discussed. A discussion of the benefits of using an energy converter made specifically for energy harvesting is also covered. A commercially available energy harvester converter is simulated using a simulation program with integrated circuit emphasis, and a solar application is tested with hardware. The hardware experiments explore the startup sequence of the circuit, the switching profile of the converter, and a test of the circuit's efficiency. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37593

Keywords: energy harvesting, power conversion, boost converter, maximum power point tracking, synchronous converter, renewable energy

AUTOMATION OF CYBER PENETRATION TESTING USING THE DETECT, IDENTIFY, PREDICT, REACT INTELLIGENCE AUTOMATION MODEL

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Co-Advisor: John McEachen, Department of Electrical and Computer Engineering

The design and implementation of a systems approach to a scalable, standardized automated cyber penetration testing system using the Detect, Identify, Predict, React (DIPR) intelligence automation model and data interoperability standards is the focus of this thesis. The system fuses information from multiple freeware programs that can be thought of as cyber sensors into an interoperable, robust whole in a manner that can tailor itself and learn over time. The groundwork is laid for an enduring system that can adapt to changing systems and vulnerabilities. A bare-bones proof-of-concept system is implemented and tested using NMap and Ettercap with the proposed DIPR XML file formats as the data intelligence automation standardization mechanism. By implementing this automated cyber penetration system, labor-intensive and costly cyber penetration testing can be simplified by reducing the amount of hand coding and manual testing. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37612

Keywords: automated penetration testing, DIPR artificial intelligence model, XML standardization

BALLISTIC MISSILE TRACKING USING THE INTERACTING MULITPLE MODEL JOINT PROBABILISTIC DATA ASSOCIATION FILTER

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Second Reader: Xiaoping Yun, Department of Electrical and Computer Engineering

The success of interceptors used by the United States ballistic missile defense program is jeopardized by the use of hostile missile decoy deployment and evasive maneuvers. The ability to discriminate between legitimate threats and decoys is a crucial requirement for interceptor algorithms. The feasibility of the interacting multiple model joint probabilistic data association filter to effectively track a ballistic missile and detect decoys and maneuvers is the focus of this thesis. Model development and data association schemes are discussed along with optimized values for selected parameters. Performance comparisons of the resultant algorithm to a standard Kalman filter utilizing a nearest neighbor discriminator are conducted. Scenarios include combinations of missile maneuver and decoy deployment. While the Kalman filter experiences limited success, the proposed filter tracks the missile in every scenario. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37618

Keywords: interacting multiple model, joint probabilistic data association filter, ballistic missile, decoy

AN INVESTIGATION OF THE EFFECTIVENESS OF SOLAR POWER ON NAVY SURFACE COMBATANTS

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Second Reader: Daniel Nussbaum, Department of Operations Research

With energy consumption and environmental concerns taking the forefront in this nation, the United States Navy is playing its part by committing itself to reduce its reliance on fossil fuels both at sea and ashore. Solar power is one method by which the Navy can help reach its energy goals. The practicality of equipping its surface combatants with solar panels to aid in the generation of shipboard power in order to reduce the

consumption of traditional fossil fuels is examined in this thesis. Such a measure would be beneficial both at sea and in port, for the sun does not discriminate where it shines. In order to accomplish this, research was done into the available surface area associated with various ship classes, current fuel and energy consumption figures both at sea and in port, estimates of how much fuel and money could be saved, what effect the panels will have on tactical factors, and different means of storing the energy generated from the panels. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37652

Keywords: solar power, navy surface combatants, energy storage, tactical feasibility

REDUCING STATOR CURRENT HARMONICS FOR A DOUBLY-FED INDUCTION GENERATOR CONNECTED TO A DISTORTED GRID

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Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

The Department of Defense (DoD) is increasing its demand for reliable renewable energy sources. The doubly-fed induction generator (DFIG) is widely used to extract electrical energy from wind and is a useful means for the DoD to achieve its renewable energy goals. The DFIG is susceptible to electric grid voltage harmonics, which is a potential obstacle for implementing stable wind-energy systems. Two existing rotor voltage controllers are modeled in this thesis for eventual implementation in a laboratory DFIG wind energy system. The first controller uses multiple proportional-integral (PI) controllers to filter out the fifth and seventh stator current harmonics. Each PI controller operates in a reference frame that rotates in synchronicity with the harmonic that is being filtered. The second controller operates in the synchronous reference frame and simultaneously filters both the fifth and seventh stator current harmonics using a double integrator called a proportional-resonant (PR) controller. The PI controller is shown to be more effective at eliminating the stator current than the PR controller but has a slower reaction time. The PR controller requires fewer computations but has more stability concerns. Both controllers reduce torque oscillations resulting from the grid distortion by approximately the same amount. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37693

Keywords: doubly-fed induction generator, DFIG, harmonic distortion, resonant controller

DESIGN OF DISCRETE TIME RADIO RECEIVER FOR THE DEMODULATION OF POWER-SEPARATED CO-CHANNEL SATELLITE COMMUNICATION SIGNALS

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Master of Science in Space Systems Operations
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Second Reader: Scott Matey, Space Systems Academic Group

This thesis has two purposes: (1) to document the design of a discrete-time radio receiver for the coherent detection of a QPSK signal in the presence of additive white Gaussian noise; and (2) further research into the performance of representative receivers in the successive demodulation of power-separated, co-channel satellite communications signals. Several commercial companies are offering satellite modulators and demodulators that allow frequency reuse over satellite communications links. There are two methods to demodulate these co-channel signals. The first method requires a priori knowledge of one of the two signals linearly superimposed in the satellite downlink. With this knowledge, the known signal is cancelled using subtraction to reveal the unknown co-channel signal. A second method of recovering both signals is possible if adequate power separation of the two signals allows recovery of the strong signal. After recovery of the strong signal, the data can be re-modulated and then cancelled from the composite signal to reveal the weak signal. This method has the advantage of not requiring a priori information, which widens the ap-

plications for layered modulation techniques to simplex, broadcast, and multi-cast network architectures. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37719

Keywords: satellite communications, frequency reuse, layered modulation, discrete-time radio design, software defined radio

DYNAMIC TOWED ARRAY MODELS AND STATE ESTIMATION FOR UNDERWATER TARGET TRACKING

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Co-Advisor: Xiaoping Yun, Department of Electrical and Computer Engineering

The ability of towed linear hydrophone arrays (TLA) to detect submarine-emitted narrow band tonals makes them the submarine tracking sensor of choice. Recent TLA improvements allow surface ships, unmanned underwater vehicles (UUVs), unmanned surface vehicles (USVs), and submarines alike to detect modern submarines by towing arrays. Allowing the full spectrum of Navy assets access into the anti-submarine warfare (ASW) arena is vital for countering future submerged threats. The generation of dynamic TLA and state estimation models in Simulink is detailed in this thesis. The dynamic TLA model receives user-specified TLA parameters and performs Dolph-Chebyshev optimization to form a set of beams which are steered for tracking. The TLA parameters can be specified to meet the needs of the towing vehicle, whether it is a submarine, ship, USV, or UUV. The state estimation model uses outputs received from a mobile platform towing an array to estimate the target state. The state estimation model uses both bearing-only and Doppler-bearing extended Kalman filters to estimate target state. These models provide a basic platform that can be used to enhance ASW capabilities. Specifically, the models can aid in determining optimal future ASW-asset allocation, improving TLA tracking algorithms, and improving information presented to submarine operators. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37725

Keywords: submarine, unmanned underwater vehicles, UUV, unmanned surface vehicles, USV, anti-submarine warfare, ASW, towed linear array, TLA, beamforming, Dolph-Chebyshev optimization, bearings-only tracking, Doppler-bearing tracking, extended Kalman filter, DBT, BOT

A SPATIOTEMPORAL CLUSTERING APPROACH TO MARITIME DOMAIN AWARENESS

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Advisor: Jim Scrofani, Department of Electrical and Computer Engineering
Co-Advisor: Murali Tummala, Department of Electrical and Computer Engineering
Second Reader: David Garren, Department of Electrical and Computer Engineering

Spatiotemporal clustering is the process of grouping objects based on both their spatial and temporal similarities. This approach is useful when considering the distance between objects and how that distance changes through time. Spatiotemporal clustering analysis is applied to the maritime domain in this thesis—specifically, to a defined area of water, during a period of time, in order to gain behavioral knowledge of vessel interactions and provide the opportunity to screen such interactions for further investigation. The proposed spatiotemporal clustering algorithm spatially clusters vessels in the water space using k-means clustering analysis; kinematically refines the clusters based on the similarity of vessel headings, speeds and the distance between them; and temporally analyzes the continuity of membership of the kinematic clusters through time to determine which clusters are moving. The algorithm is implemented in the MATLAB programming environment, verified with a synthetic data scenario, and validated with two real-world datasets. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37731

Keywords: spatiotemporal clustering, maritime domain awareness

MASTER OF SCIENCE IN ELECTRONIC WARFARE SYSTEMS ENGINEERING

TECHNOLOGICAL ADVANCEMETS IN EW: A WAY FORWARD FOR ROYAL SAUDI NAVAL FORCE

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Master of Science in Electronic Warfare Systems Engineering
Advisor: David Jenn, Department of Electrical and Computer Engineering
Co-Advisor: Edward Fisher, Department of Information Sciences
Second Reader: Joshua Green, Department of Information Sciences

The modern battlefield has become exceedingly complex and technology-driven. It is signified by highly sophisticated surveillance systems, thereby resulting in reduced time for decision making, execution of orders and conduct of operations. This reduced response time is essentially due to non-availability of requisite enemy data and presentation of information extracted from that data in a less understandable format. Modern electronic warfare systems are designed to process such information automatically to facilitate decision makers in better understanding of the battlefield situation and making quick decisions, thereby allowing more response time to the warfighter on the scene. Saudi Arabia, the 13th-largest nation in the world, is located in an oil rich region and shares its borders with Iraq, Kuwait, Bahrain, Oman, Yemen, Jordan, and the United Arab Emirates. This region has been in a state of conflict for many decades. The Iraq–Iran war, the Iraqi occupation of Kuwait, Operations Enduring Freedom and Desert Shield, Iran's ambitions of becoming a nuclear power, and Syria's civil war are examples of recent and ongoing conflicts. As a regional power, Saudi Arabia has its economic interests coupled with regional security. With more than 2,000 kilometers of coastline to defend, Saudi Arabia faces the challenge of keeping economically vital sea lines of communication open for the export of crude oil and other petroleum products. All these factors demand a high degree of operational readiness by the Royal Saudi Armed Forces, especially the Royal Saudi Naval Force. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37578

Keywords: RSNF, electronic warfare, EW, RADAR, gap analysis, technical aspects of EW, C4I , Saudi Arabia

FMCW RADAR JAMMING TECHNIQUES AND ANALYSIS

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Co-Advisor: David Garren, Department of Electrical and Computer Engineering
Second Reader: Edward Fisher, Department of Information Sciences

Frequency-modulated continuous-wave (FMCW) radar is a type of low probability of intercept radar system that is being heavily investigated in the military. Not only is its transmission difficult to be detected by enemy intercept receivers, but FMCW radar has the inherent capability of increasing coherent signal power while suppressing noise power during its receive signal processing. This thesis investigates the jamming effectiveness of selected jamming waveforms by injecting the interfering signals into the Lab-Volt Radar Training System (LVRTS). The jamming effect is evaluated based on the change in beat frequency due to the jamming. Due to the hardware limitations of the LVRTS, a MATLAB simulation model is also constructed for advanced electronic attack testing. The MATLAB model emulates the FMCW emitter digital signal processing response to coherent and non-coherent jamming signals under an anti-ship capable missile scenario. The simulation output is the target range and

range rate, whose error measures quantify the jamming effectiveness. From the standpoint of electronic warfare, related subjects such as electronic warfare support measures and FMCW electronic protection are also discussed. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37597

Keywords: frequency-modulated continuous-wave radar, FMCW Radar, low probability of intercept, LPI, jamming, electronic warfare

DYNAMIC BANDWIDTH PROVISIONING USING MARKOV CHAIN BASED ON RSVP

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Advisor: Preetha Thulasiraman, Department of Electrical and Computer Engineering
Second Reader: Joshua Green, Department of Information Sciences

An important aspect of wireless communication is efficiency. Efficient network resource management and quality of service (QoS) are parameters that need to be achieved, especially when considering network delays. The cooperative nature of unmanned ground vehicle (UGV) networks requires that bandwidth allocation be shared fairly between individual UGV nodes, depending on necessity. In this thesis, we study the problem of dynamic bandwidth provisioning in a UGV network. Specifically, we integrate the use of a basic statistical model, known as the Markov chain, with a widely known network bandwidth reservation protocol, known as the Resource Reservation Protocol (RSVP). The Markov chain results are used with RSVP to identify specific bandwidth allocation requirements along a path such that data transmission along that path is successful. Using a wireless simulation program known as Qualnet, we analyze the bandwidth efficiency and show that this algorithm provides higher bandwidth guarantees and better overall QoS when compared with solely using RSVP in wireless communication networks. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37708

Keywords: wireless communication, resource reservation protocol, Markov Chain Process, dynamic bandwidth allocation

MASTER OF SCIENCE IN ENGINEERING ACOUSTICS

AN EXAMINATION OF THE ABILITY OF OCEAN OBERVATORY SYSTEMS TO DETERMINE MERCHANT SHIP DIRECTION AND DRAFT

Richard Hunt–Lieutenant, United States Navy
Master of Science in Engineering Acoustics
Advisor: Daphne Kapolka, Department of Physics
Second Reader: Kevin Smith, Department of Physics

The objective of this thesis was to analyze data obtained from a network of ocean bottom seismometers to determine if it could be used to provide detailed information regarding merchant vessels such as their direction and draft. The sensors were located in the Strait of Juan de Fuca and collected data from August–September 2009. The hydrophone and three orthogonal seismometer channels were beamformed in MATLAB as a vector sensor in an attempt to get bearing data on a passing ship. Frequencies were limited to about 80Hz due to the low sampling frequency. A Lloyd's mirror pattern from the ships broadband noise was visible in the lofargrams from all four channels during this transit. The Lloyd's mirror pattern was compared qualitatively with theoretical predictions from ray theory as well as with transmission loss predictions from the parabolic equation model run in PC-IMAT. Vector sensor beamforming proved unsuccessful due to the lack of coherence and erratic phase differences among the sensors. This erratic behavior is probably due to multipath effects. Both ray theory and PC-IMAT models show promise for exploiting the Lloyd's mirror patterns. The expected interference patterns show a clear dependence on range and draft. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37642

Keywords: acoustics, interference, vector sensor, Lloyd's mirror, lofargram

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MASTER OF SCIENCE IN ENGINEERING SCIENCE

COMPUTATION OF WEAPONS SYSTEMS EFFECTIVENESS

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Advisor: Morris Driels, Department of Mechanical and Aerospace Engineering
Co-Advisor: Christopher Adams, Department of Mechanical and Aerospace Engineering

The main objective of the thesis is to develop an unclassified MATLAB-based Weapons Systems Effectiveness program with user-friendly Excel-based graphical user interface to evaluate the effectiveness of air-to-surface (AS) and surface-to-surface (SS) weapons. The program allows users to compute the effectiveness of their weapons based on the initial release/firing condition for both AS and SS weapons. The effectiveness is determined by predicting the probability of success of damaging or incapacitating the target. The program also allows the calculation of the trajectory of unguided AS weapons and the computation of the weapon accuracy of AS weapons. The main functionality provided by the program includes computing the weapon effectiveness of single release of weapons against unitary and area targets, stick deliveries, cluster munitions and projectiles for AS weapons, as well as direct and indirect SS weapons. The entire program is modeled on the theory detailed in M. R. Driels textbook, Weaponeering Conventional Weapon System Effectiveness, published in 2013 by the AIAA. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37686

Keywords: Weapons Effectiveness Program, probability of damage, weapon trajectory, weapon accuracy

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MASTER OF SCIENCE IN HUMAN SYSTEMS INTEGRATION

AN INTER-RATER COMPARISON OF DOD HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM (HFACS) AND HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM MARITIME (HFACS-M)

Jason Bilbro–Lieutenant, United States Navy
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Advisor: Lawrence Shattuck, Department of Operations Research
Second Reader: Samuel Buttrey, Department of Operations Research

Human error has been identified as a factor in virtually every major maritime mishap over the past decade. The Department of Defense (DoD) currently employs the Human Factors Analysis and Classification System (HFACS) taxonomy to identify and quantify human error in major mishaps. HFACS divides errors into categories, sub-codes, and nano-codes. The generic nature of DoD HFACS raises the question of whether or not a domain-specific version for the surface Navy could be applied more consistently. Twenty-eight subjects (14 Surface Warfare Officers (SWOs) and 14 non-SWOs) employed either DoD HFACS or a developmental maritime domain specific version, HFACS-M, to classify findings in a National Transportation Safety Board maritime accident investigation. Fleiss Kappa was used to determine inter-rater reliability among subjects. The results of this study revealed that SWOs using HFACS-M had a higher inter-rater reliability (10.9%, 7.3%, and 6.5%) at every classification level than non-SWOs. HFACS-M itself was also shown to have a slightly higher overall inter-rater reliability (5.7%, 7.4%, and 3.6%) than DoD HFACS. The research concluded that although HFACS-M performed well, further testing is necessary to validate it. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37586

Keywords: human systems integration, safety, mishaps, human factors, Human Factors Analysis and Classification System, HFACS

EFFECTS OF SLEEP DEPRIVATION ON U.S. NAVY WATCHSTANDER PERFORMANCE ONBOARD THE INDEPENDENCE CLASS LITTORAL COMBAT SHIP (LCS- 2)

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Master of Science in Human Systems Integration
Advisor: Christian Smith, Department of Operations Research
Second Reader: Nita Shattuck, Department of Operations Research

In spite of the incredible technologic advances over the history of the U.S. Navy, the human operator continues to be the most important part of any system. The littoral combat ship (LCS) concept proposed to reduce the number of sailors required to run a ship by leveraging new technologies. While the consequences of this manning decision are debatable, the effect of fatigue on a ship's crew and their ability to perform is not. Using archival sleep data obtained from LCS-2, this thesis assessed the relationship between fatigue and crew member performance on the Psychomotor Vigilance Test and the Switching Test. While the regression analyses did not yield statistically significant results, the chi-square test showed that a significant departure occurred from the sleep obtained by LCS-2 crew members and the 480 minutes of daily sleep recommended in the NSWW. The effect of fatigue on a ship's crew requires further research, and a course of action is presented in the recommen-

dations of this thesis that would help researchers obtain the necessary data for proper sleep study analyses. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37607

Keywords: sleep, fatigue, actigraphy, fatigue management, Fatigue Avoidance Scheduling Tool, FAST, sleep deprivation, Navy standard workweek, NSWW, psychomotor vigilance test

ASSESSING MOTION INDUCED INTERRUPTIONS USING A MOTION PLATFORM

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Second Reader: Christian Smith, Department of Operations Research

Human performance contributes to total system performance. As human performance decreases, total system performance decreases while lifecycle costs increase. In a fiscally constrained environment, human systems integration (HSI) seeks to assure human performance to reduce operating costs. This thesis seeks to develop a model for ship design in relation to motion induced interruptions (MII). The model is based on the premise that MIIs affect specific domains of HSI in an adverse way. Future ship design considerations that mitigate MII occurrences can save the Navy money spent on human injury and system degradation. The thesis begins with a historical overview of MII theory and development and its interactions with domains of HSI. An MII prediction model was developed using data acquired from an experiment using a motion-based platform that emulates ship motion. Quantitative data were analyzed from 21 subjects who underwent 32 trials. Multiple regression analysis consisted of two independent variables as period and lateral acceleration and the response variable as an MII incident. Logistic regression considered two more independent variables that addressed individual differences. Data analysis revealed that acceleration, period, and human balance were statistically significant. The proposed multiple regression model accounted for 77% of the variance of MII forecasting. This thesis lays the foundation for future quantitative analysis of interactions between MIIs and accelerations or periods in different axes. Additionally, it provides an initial model that predicts conditions of high MII incident environments that can ultimately lead to a viable design tool for HSI practitioners and ship designers. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37631

Keywords: HSI, human systems integration, motion induced interruptions, MII

A CAPABILITIES BASED ASSESSMENT OF THE UNITED STATES AIR FORCE CRITICAL CARE AIR TRANSPORT TEAM

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Second Reader: Nita Shattuck, Department of Operations Research

The United States Air Force Critical Care Air Transport (CCAT) mission is an American military tradition that has saved thousands of lives by providing airborne medical care to the critically ill and wounded. This life-saving mission is executed by CCAT teams, which usually consist of a critical care physician, critical care nurse, and respiratory therapist. A front-end analysis has found several problems within the CCAT system, justifying a need for further examination. Members from the 711th Human Performance Wing Human System Integration Directorate, Survivability Vulnerability Information Analysis Center, and the Naval Postgraduate School formed an analysis team to conduct a capabilities based assessment (CBA) on the CCAT system using a human systems integration (HSI) perspective. The CBA identifies current and future capability gaps in the CCAT system and provides prioritized HSI domain and doctrine, organization, training, materiel, leadership policy and education, personnel, facilities, and policy (DOTmLPF-P) recommendations that will close those gaps. This thesis documents how the analysis team applied HSI principles throughout the CBA process. It demon-

strates the importance of the human perspective and examines how specific HSI tools, techniques, approaches, and methods (TTAMs) can be used in the early stages of the Department of Defense acquisition process. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37671

Keywords: human systems integration, United States Air Force, Critical Care Air Transport, CCAT, capabilities based assessment, CBA

PERFORMANCE ASSESSMENT OF MILITARY TEAMS IN SIMULATOR AND LIVE EXERCISES

This thesis has been recognized as outstanding by its department.

Frode Mjelde–Lieutenant Commander, Royal Norwegian Navy
Master of Science in Human Systems Integration
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Second Reader: Michael McCauley, Department of Operations Research

The purpose of this paper is to present and evaluate a tool designed to assess the performance of military teams participating in complex military training exercises and to investigate the effectiveness of simulator training and live training from the matching of inherent stressors. Specifically, this study evaluates a tool that has been used by Norwegian military subject matter experts to assess the performance of eight cadet teams at the Royal Norwegian Naval Academy (RNoNA) during two separate 4-hour simulator exercises and a 48-hour live exercise. The resulting positive Spearman rank correlation coefficients between team performance assessments in the simulator exercises and the live exercise were strongest when the simulator scenario emphasized the stressors inherent in the live exercise and weakest when the simulator scenario did not facilitate the task demands in the live exercise. The study showed that (1) team performance measured in simulator training exercises can predict performance in a subsequent live training exercise, and (2) scenario-based simulator training can realistically and effectively represent training demands for live operations. Our findings show that the RNoNA tool can be easily applied to team training exercises and provide a meaningful evaluation of a team's future performance. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37677

Keywords: human systems integration, manpower, personnel, training, human factors engineering, military teams, team training, team performance, team performance assessment, teamwork, taskwork, Norwegian Naval Academy, simulator systems, virtual environment, live environment, reduced cost, improved schedule, improved performance

TAILORING MIL-STD-1472G: DEVELOPING A SYSTEM-LEVEL MANPRINT REQUIREMENTS DOCUMENT FOR CONTRACT USE IN THE ACQUISITION OF MILITARY GROUND COMBAT VEHICLES

Deborah Swain–Civilian, Department of Defense
Master of Science in Human Systems Integration

This document has been created to initiate an artifact which can be further developed into a hard contract requirements document that will mandate human design requirements as critical and requiring accountability on programs. By quantifying high-level human systems integration requirements, human engineers are able to provide the pass/fail criteria sought by hardware engineers. The battle now is to review those documents which we use on a daily basis and tailor out those that fall under systems design and sub-systems design. Currently, human engineering documents are organized to cover general design and detailed design all in one paragraph. The intention of tailoring these requirements out and breaking them down by domain is to increase the ease of reviewing these documents and only provide the up-front information that is most critical for design of a specific system. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37053

Keywords: human systems integration, HSI, requirements, MANPRINT, human factors engineering, soldier survivability, system safety, health hazards, manpower, personnel, training, MIL-STD-1472G

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MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

ANALYSIS, DESIGN AND IMPLEMENTATION OF A PROOF-OF-CONCEPT PROTOTYPE TO SUPPORT LARGE-SCALE MILITARY EXPERIMENTATION

This thesis has been recognized as outstanding by its department.

Eid Alqhatani–Lieutenant Commander, Royal Saudi Naval Forces
Fahad Huwaymil–Lieutenant Commander, Royal Saudi Naval Forces
Master of Science in Information Technology Management
Master of Business Administration
Advisor: Magdi Kamel, Department of Information Sciences
Co-Advisor: Walter Kendall, Department of Information Sciences
Second Reader: Douglas Brinkley, Graduate School of Business and Public Policy

FORCEnet Innovation and Research Enterprise (FIRE) is an enterprise computer-based solution developed to support large-scale experimentation in the Navy and Department of Defense. Every year, experiments are conducted such as Trident Warrior (TW) events to assess new capabilities developed to achieve FORCEnet concept. FIRE is also used to support experimentation in other projects and for other services. FIRE was built by the Naval Postgraduate School to provide the necessary tools for the coordination of the planning, execution and reporting of these experiments. Since its inception in 2003, FIRE has played an essential role in TW by empowering all stakeholders with the collaborative and management tools to perform tasks that were time-consuming and manpower-intensive in the past. However, a survey conducted a few years ago showed that FIRE lacks some required features and improvement in various areas needed to be considered. The objective of this thesis was to design, develop, and test a proof-of-concept prototype of an improved web-based application to support the coordination of large-scale experimentation to address the shortcomings of the old FIRE system. This was achieved by using the following: a modern design approach, the Model-View-Controller, a state-of-the-art framework, Oracle Application Development Framework, and powerful development tools such as Oracle JDeveloper and Oracle WebCenter. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37579

Keywords: FORCEnet, FORCEnet Innovation and Research Enterprise, FIRE, web-based application, Oracle Application Development Framework, Oracle ADF, Trident Warrior, experiment, model-view-controller, MVC

NAVY ERP: AN ANALYSIS OF CHANGE MANAGEMENT

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Second Reader: William Robinette, Department of Information Sciences

The Department of Defense (DoD) is an immense organization that utilizes thousands of business systems at a cost in the billions of dollars for the operation, maintenance, and modernization of these systems. During the past decade, enterprise resource planning (ERP) systems have become a primary focus within the DoD in an effort to minimize the amount of business systems and bring about process integration across the Services. The DoD has invested billions of dollars toward the development and implementation of numerous ERPs in the past decade.

Unfortunately, a few of these ERP implementations have resulted in failure while a majority of other ERPs are experiencing cost overruns and schedule delays. With existing budget constraints, it is imperative that the DoD conduct research to further the development of appropriate ERP implementation approaches. One key attribute of implementing an ERP is change management. Extensive private industry research has been conducted on change management and identifies change management as a critical success factor for any widespread organizational changes. ERPs fit this model and typically involve drastic organizational change. As the DoD seeks to enlarge and transform its enterprise, there is a need for change management research on recent DoD ERP implementations. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37589

Keywords: enterprise resource planning, change management, organizational change, Navy ERP, United States Navy, Naval Supply Systems Command, Department of Defense, DoD, ERP critical success factors

DOD INFORMATION TECHNOLOGY ACQUISITION: DELIVERING INFORMATION TECHNOLOGY CAPABILITIES EXPEDITIOUSLY

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Master of Science in Information Technology Management
Advisor: Thomas Housel, Department of Information Sciences
Co-Advisor: Johnathan Mun, Department of Information Sciences

Maintaining an information advantage for the Department of Defense (DoD) and its military departments is critical to national defense objectives, and the acquisition of new information technology (IT) is key. The DoD seeks to quickly acquire IT systems that meet requirements and are within budget; however, this goal has been very difficult to achieve, given the cumbersome and deliberate process through which IT systems have been acquired. Essentially, the DoD's acquisition process cannot keep pace with the rapid development of IT systems that occurs in the commercial sector. For years, the DoD has relied on a common approach in acquiring different systems and services. This approach has been laced with inefficiencies and inadequacies that have resulted in prolonged schedules as well as increased cost. Currently, the DoD is implementing a new IT acquisition process; however, this new process does not resolve all the issues that have plagued IT acquisition. This study will identify the causes or impeding factors that have prevented the DoD from acquiring new IT systems in a timely manner and will recommend alternative solutions to solving the problems. Ultimately, this thesis contributes to the DoD's efforts to resolve the issues that continue to undermine timely IT acquisition. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37591

Keywords: government acquisition process, information technology, IT, Department of Defense, DoD, information systems, military procurement, policies, timeliness, transformation, deficiencies, commercial off-the-shelf equipment, acquisition reform, change management, Defense Business Systems

DEPLOYING CROWD-SOURCED FORMAL VERIFICATION SYSTEMS IN A DOD NETWORK

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Master of Science in Information Technology Management
Advisor: Geoffrey Xie, Department of Computer Science
Second Reader: Thomas Housel, Department of Information Sciences

Manual formal software verification is an expensive and time-consuming process. Military software is currently verified manually by highly skilled analysts. To reduce the high costs of the formal verification, DARPA started a crowd-sourced formal verification (CSFV) program that aims to include as many people as possible to participate in this verification process by embedding some of the verification logics into computer games. In this study we built a network prototype for hosting a CSFV server on a DoD network. The CSFV network prototype is designed according to the common security practices, necessary security measures against possible attacks, and the Security Technical Implementation Guides (STIGs) published by the Defense Infor-

mation Systems Agency to provide confidentiality, integrity and availability. Important details are presented about server operating system selections, proper usage of necessary network services, and firewall and intrusion detection system rules for efficient network security. Results from common network penetration test tools confirm that our prototype meets the necessary security requirements and can be trusted on a DoD network. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37617

Keywords: crowd sourced formal verification, network security, cyber attacks, crowdsourcing, virtualization, cloud computing, firewalls, intrusion detection systems, IDS, network penetration test

CROWDSOURCING ISR: A SYSTEMS THINKING APPROACH TO KNOWLEDGE DYNAMICS IN INTELLIGENCE OPERATIONS THROUGH APPLICATION OF COLLABORATIVE FILTERS

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Master of Science in Information Technology Management
Advisor: Alex Bordetsky, Department of Information Sciences
Co-Advisor: Wayne Porter, Global Public Policy Academic Group

The Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise (MCISR-E) faces ever-increasing complexity in the conduct of expeditionary operations. This research seeks to explore computer-supported collaborative work of the MCISR-E. Properties of networks and complexity are explored through a systems thinking perspective on collective intelligence. Online social networking information technology is examined for demonstration of emergent knowledge creation for sensemaking in the computer-supported collaborative work of MCISR-E. This is provided through use cases of commercial off-the-shelf online social networking technology and crowdsourcing applications. Crowdsourcing through social networking technology, as it benefits both collaborative information seeking and collaborative filters, is suggested as possible fit to the MCISR-E. Use cases demonstrate this fit at the technical, organizational and individual levels. The MCISR-E is a complex adaptive system, designed to raise the collective intelligence of Marine Corps units. Collective intelligence is defined as groups of people doing things intelligently. MCISR-E must effectively demonstrate sensemaking through knowledge creation to achieve this goal. MCISR-E processes must predict and react to events by group work capitalizing on current and new technology. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37638

Keywords: Marine Corps, ISR, MCISR-E, intelligence, crowdsourcing, collaboration, adaptation, technology, network-centric warfare, complex adaptive systems, open systems, systems thinking, systems dynamics, social networks, emergence, autopoiesis, self-organization, knowledge dynamics, computer supported collaborative work, knowledge networks

UNDERSTANDING RETURN ON INVESTMENT FOR DATA CENTER CONSOLIDATION

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Master of Science in Information Technology Management
Advisor: Glenn Cook, Department of Information Sciences
Second Reader: Thomas Housel, Department of Information Sciences

The federal government has mandated that agencies consolidate data centers in order to gain efficiencies and cost savings. It is a well-established fact that both public and private organizations have reported considerable cost savings from consolidating data centers; however, in the case of federal agencies, no established methodology for valuing the benefits has been delineated. Nevertheless, numerous federal policies mandate that investments in IT demonstrate a positive return on investment (ROI). The problem is that the Department of Defense does not have clear instructions on how to measure ROI in order to evaluate an opportunity to consolidate data centers. While calculating ROI for IT can be very challenging, most private and public firms have methods for demonstrating a return ratio and not only cost savings. Therefore, choosing metrics

and methodologies for calculating ROI is an important step in the decision-making process. This complexity complicates estimating a data center's utility and the true value generation of merging data centers. This thesis will explore the challenges that the Marine Corps faces for calculating ROI for data center consolidation. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37641

Keywords: DoD, stakeholder based value model, Marine Corps Installations Command, MCICOM, Marine Corps Installations-West, MCI-W, data center consolidation, DCC, return on investment, ROI, Federal Data Center Consolidation Initiative, FDCCI, Marine Corps

CLOUD COMPUTING SOLUTIONS FOR THE MARINE CORPS: AN ARCHITECTURE TO SUPPORT EXPEDITIONARY LOGISTICS

Charles Ibatuan II–Captain, United States Marine Corps
Master of Science in Information Technology Management
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Co-Advisor: Albert Barreto, Department of Information Sciences

The Department of Defense (DoD) is planning an aggressive move toward cloud computing technologies. This concept has been floating around the private information technology sector for a number of years and has benefited organizations with cost savings, increased efficiencies, and flexibility by sharing computer resources through networked connections. The push for cloud computing has been driven by the 25 Point Implementation Plan to Reform Federal Information Technology Management, which highlighted the shift to a cloud first policy. The cloud first policy has driven the DoD—specifically, the Marine Corps—toward cloud computing technologies, making this relatively new paradigm inevitable. The Marine Corps has provided its cloud computing guidance through its Private Cloud Computing Environment Strategy. However, the urgency for the Marine Corps to implement a cloud computing architecture that will support enhanced logistical systems in an expeditionary environment needs to be tempered by a comprehensive evaluation of current cloud computing technologies, virtualization technologies, and local versus remote logistical data types and sub-sets. This thesis seeks as its goal to explore and analyze current cloud computing architectures and virtualization technologies to determine and develop a cloud computing architecture that best supports expeditionary logistics for the Marine Corps. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37643

Keywords: cloud computing, virtualization, virtual desktop infrastructure, virtual machines, thin client, zero client, logistic systems, decision support systems

COST REDUCTION THROUGH THE USE OF ADDITIVE MANUFACTURING (3D PRINTING) AND COLLABORATIVE PRODUCT LIFE CYCLE MANAGEMENT TECHNOLOGIES TO ENHANCE THE NAVY'S MAINTENANCE PROGRAMS

Michael Kenney–Lieutenant Commander, United States Navy
Master of Science in Information Technology Management
Advisor: Thomas Housel, Department of Information Sciences
Second Reader: Johnathan Mun, Department of Information Sciences

In order to keep its ships and aircraft in an operational status, the U.S. Navy must have access to the parts necessary for repair. Current supply warehouses do not always carry the required repair parts; therefore, when parts are unavailable, the Navy must either look to traditional acquisition sources or utilize manufacturing capabilities available at depot and intermediate maintenance activities. This thesis examines the potential cost benefits of incorporating additive manufacturing (AM), commonly known as 3D printing, and collaborative product life cycle management (CPLM) software into these maintenance activities. The research uses the knowledge value added methodology to analyze modeled data and capture and quantify the benefits of introducing AM and CPLM technologies into Navy maintenance activities. This proof of concept was developed to apply AM and CPLM

to as-is and several to-be maintenance process models in order to measure the potential benefits. By introducing AM and CPLM technologies into the current manufacturing process, the notional scenario showed positive results and suggests a significant reduction to cycle time and a potential cost savings of $1.49 billion annually. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37648

Keywords: additive manufacturing, AM, 3D printing, knowledge value added, KVA, collaborative product lifecycle management, CPLM

VOLATILITY MEASUREMENTS APPLIED TO INFORMATION SYSTEMS

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Advisor: Thomas Housel, Department of Information Sciences
Second Reader: Johnathan Mun, Department of Information Sciences

Inappropriate and/or duplicate IT systems results in a severe drain on resources. Identifying the development of low utility and duplicate systems allows for the redirection of resources with higher and unique returns. Volatility measurements allow systems to be compared to determine the gains over prior iterations along with aiding in determining which options to exercise for future systems. The decision maker of an organization must be able to monitor how IT systems are functioning and hold program managers and developers accountable for improving efficiency, timeliness, and accuracy of the information being gather and processed. Volatility measurements take consideration of all factors and give a baseline from which the IT manager can make decisions across systems. The additional capabilities provided by volatility measurements will go a long way in strengthening IT investments and the performance review of those systems, and it provides the additional information needed to forecast and compare systems in order to make better decisions. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37650

Keywords: volatility, risk, beta, information systems

ONE SIZE DOES NOT FIT ALL: A SYSTEM DEVELOPMENT PERSPECTIVE

This thesis has been recognized as outstanding by its department.

Erik LaSalle–Lieutenant Commander, United States Coast Guard
Master of Science in Information Technology Management
Advisor: John Osmundson, Department of Information Sciences
Second Reader: Kishore Sengupta, Department of Information Sciences

Investments in technology have the potential to improve lives and organizations and can be force multipliers for an organization; however, federal IT projects too often experience cost overruns, schedule slippages, and performance shortfalls. Specific to the Coast Guard, there are currently four Information Technology Level 1 acquisitions programs that have life-cycle costs estimates equal to or greater than $1 billion. Many of these projects are over budget, and, as a result, many of the desired capabilities do not make it to the end user. Since the passage of the first Acquisition Act and every acquisition mandate since, the federal government has struggled to deliver capabilities that have met the requirements of the end-user, while staying within budget, on schedule and within cost. To alleviate this, adding more mandates and oversight has become the go to play. However, these mandates just might be having the antithesis effect on desired outcomes. This thesis describes alternative system development methodologies that could assist the Department of Homeland Security and Department of Defense in maximizing the delivery of capabilities to the end-user while staying on schedule and within budget. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37656

Keywords: WatchKeeper, Mission and Asset Scheduling Interface, MASI, agile, software development, project management, computer, engineering process, life-cycle, acquisition

A CASE ANALYSIS TO INCREASE AWARENESS OF CURRENT USMC KNOWLEDGE MANAGEMENT (KM) PRACTICES

Nicholas Lemich–Captain, United States Marine Corps
Master of Science in Information Technology Management
Advisor: Mark Nissen, Department of Information Sciences
Second Reader: Jim Robinette, Department of Information Sciences

The practice of knowledge management (KM) continues to grow within the Department of Defense; however, while the other services have substantially matured in KM, the United States Marine Corps (USMC) has not. Most organizations today leverage information systems and technology to their advantage for increasing information, knowledge flow, and overall KM. The problem is that USMC units do not appear to be leveraging knowledge as effectively as they could, and as other services do, to address the national knowledge issue and dilemma. The purpose of this research is to identify current courses of action that the USMC is taking to mature its KM, to diagnose pathologies preventing USMC units from capitalizing on the power of KM, and to identify a framework for small-unit level implementation. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37660

Keywords: knowledge management, KM, knowledge-flow, KF

USING SOCIAL MEDIA TOOLS TO ENHANCE TACIT KNOWLEDGE SHARING WITHIN THE USMC

James Mastrom–Captain, United States Marine Corps
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Master of Business Administration
Advisor: Mark Nissen, Department of Information Sciences
Co-Advisor: Cary Simon, Graduate School of Business and Public Policy

Social media usage has exploded over the past several years. Individuals are using social media tools to stay constantly connected to friends, family and co-workers. Companies have learned to leverage these same technologies both externally and internally. These emerging social technologies, applications and platforms are an excellent way for geographically separated people to connect, communicate and share knowledge in novel ways. The United States Marine Corps (USMC) continues to communicate primarily through telephone, email and reports. The valuable resource of tacit knowledge contained within veterans of operations spanning from distributed counterinsurgencies to complex humanitarian assistance efforts is usually shared via face-to-face interaction and informal networks. Academic literature and industry adoption indicate that social media tools are now familiar and mature enough to provide an additional or even substitute conduit for this type of rich tacit knowledge sharing. How can social media tools be used to improve USMC tacit knowledge sharing? This research explores the extant use of Web 2.0-enabled social tools for the purpose of tacit knowledge sharing. A case study of a USMC unit identifies knowledge sharing pathologies and presents use cases for the application of social tools to address these pathologies. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37670

Keywords: social media, social networking, Web 2.0, knowledge management, tacit knowledge, knowledge sharing, knowledge flows, knowledge transfer, organizational learning

MILITARY RETIREMENT AND WEALTH FORECASTING DURING DOD MANPOWER DRAWDOWN

Steven Mays–Major, United States Marine Corps
Master of Science in Information Technology Management
Advisor: Thomas Housel, Department of Information Sciences
Co-Advisor: William Sharpe
Second Reader: Johnathan Mun, Department of Information Sciences

The Department of Defense will be taking preemptive action to reduce its budget in the face of imminent reduction in federal spending. The Marine Corps is projected to cut a significant percentage of its current active duty end strength. This study focused specifically on the Marine Corps population, both to limit the scope of the study and to model the effects of the manpower reduction parameters used on its target population. The Marine Corps will utilize temporary early retirement authority, voluntary separation pay, enlisted retention, and Officer Continuation Boards as the parameters to reduce its end strength in the coming years. The target population for this study was career-intentioned Marines officers defined as those Marines officers who voluntarily served beyond their initial contractual obligation by accepting a career designation status. Some will be separated prior to achieving traditional, 20-year, retirement eligibility. This study will draw comparisons between promotion probabilities from known and theoretical data using Monte Carlo simulation and other statistical methods to generate a career-decision support tool for the affected population of Marines to make informed retirement planning decisions. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37672

Keywords: retirement planning, Monte Carlo simulation, decision support, net present value, manpower drawdown, temporary early retirement authority, TERA, voluntary spearation pay, VSP

ANALYSIS AND DEVELOPMENT OF A WEB-ENABLED PLANNING AND SCHEDULING DATABASE APPLICATION

Gary Reed–Lieutenant, United States Navy
Master of Science in Information Technology Management
Advisor: Glenn Cook, Department of Information Sciences
Second Reader: William Robinette, Department of Information Sciences

This thesis is in response to the annual requirement for departmental planning and scheduling of courses and instructors within all departments at the Naval Postgraduate School. This project thesis explains the process of analyzing, designing and implementing a web-enabled database capable of providing an effective and efficient tool for departmental planners. Using standard systems analysis procedures, this thesis provides a definition of the current business process, establishes an entity-relationship diagram for the desired process, constructs an operable database using MySQL, and provides a web-enabled interface for the population of data elements, creation of annual plans and reports for the extraction of decision making information. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37699

Keywords: information Systems, IS, database management system, DBMS, DBM, entity-relationship, ER diagram, E-R diagram, relational, model, development, develop, design, process, re-engineering, reengineering, MySQL, structured query language, SQL, myPHPadmin

SERVICE-ORIENTED ARCHITECTURE APPROACH TO MAGTF LOGISTICS SUPPORT SYSTEMS

Frank Sierra–Captain, United States Marine Corps
Master of Science in Information Technology Management
Advisor: Kishore Sengupta, Department of Information Sciences
Co-Advisor: Alex Bordetsky, Department of Information Sciences

Legacy logistics systems are an antiquated technology and fall short of providing the Marine Air Ground Task Force (MAGTF) with modern, net-centric, expeditionary logistics chain management (LCM) and command and control (C2) capabilities. The Marine Corps owns more than 200 logistics information systems. While some of these systems still perform critical functions, others are stove-piped, redundant, or no longer provide an adequate modern capability. Managing legacy assets and interim technologies while concurrently developing new long-term enterprise solutions is required in order to provide the Marine Corps with the necessary logistics information technology capabilities. The envisioned future end state is logistics data shared across the MAGTF, and, ultimately, across the entire organization. A shared-data environment, populated by autonomic computing, will provide actionable logistics data to everyone in the MAGTF, from the warehouse to the warfighter position, in near real-time. Common systems supporting common techniques, tactics, and procedures equals significantly improved capabilities. The goal of this research is to envision a set of common information technology capabilities required to execute LCM missions without considering the current limitations provided by existing legacy or MLS2 information technology systems. This research will focus on implementing a service-oriented architecture approach to the MLS2 and related processes that will initiate to improve support to the decision-makers and the warfighters across the enterprise. The key end state at hand is to determine a mutually exclusive and comprehensive set of common MLS2 information technology capabilities required to execute C2 for logistics and LCM missions. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37717

Keywords: service-oriented architecture, SOA, layers of SOA, interoperability, business process modeling, BPM, business process review, BPR, enterprise resource planning, ERP, enterprise service bus, ESB, logistics chain management, LCM

UNITED STATES MARINE CORPS COST REDUCTION AND THE JOINT BATTLE COMMAND PLATFORM

David Simning–Captain, United States Marine Corps
Master of Science in Information Technology Management
Advisor: Thomas Housel, Department of Information Sciences
Second Reader: Johnathan Mun, Department of Information Sciences

The Department of Defense and United States Marine Corps are under increased pressure to reduce costs and expenditures in response to the austere financial environment. Marine Corps information technology (IT) programs are in jeopardy due to budget shortfalls, which may result in reduced military capability. The purpose of this study is to test the theory of vicious business cycles, which relates cost reduction to return on investment for the Joint Battle Command Platform. The Joint Battle Command Platform is an Acquisition Category II program of record designed to meet joint requirements for a common control and command/situational awareness system between the Army and Marine Corps. In an attempt to achieve cost savings, the JBC-P has undergone several cost reduction initiatives. Using several value metrics to measure the impact of cost reductions on the capability provided by the program, this study determines that cost reductions do reduce the value of the military capability provided by the program. These reductions could be an indication of a vicious cycle. Identifying the occurrence of vicious business cycles in

IT programs will allow decision makers to more effectively cut costs without reducing military capability. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37718

Keywords: vicious cycle, death spiral, return on investment, Joint Battle Command Platform, JBC-P, cost cutting, cost reduction, information technology, IT

THE ECONOMIC AND RISK CONSTRAINTS IN THE FEASIBILITY ANALYSIS OF WIRELESS COMMUNICATIONS IN MARINE CORPS COMBAT OPERATION CENTERS

William Travis–Captain, United States Marine Corps
Master of Science in Information Technology Management
Advisor: Alex Bordetsky, Department of Information Sciences
Second Reader: Glen Cook, Department of Information Sciences

This thesis will provide Marine Corps acquisitions and communications personnel a general understanding of wireless communications capabilities, financial feasibility, the benefits and risks of implementing a wireless solution into the current existing communications infrastructure in particular, and the Combat Operations Center (COC) CapSet models already employed and deployed throughout the Marine Corps Air Ground Task Force. The content of this thesis is of an unclassified nature. This thesis is intended to serve as a reference for acquisitions or communications personnel dealing with the acquisition, procurement, planning, and implementation of wireless technologies in the Marine Corps, so that they will be able to intelligently articulate the financial feasibility, benefits, and risks of adopting or implementing a wireless solution to the Marine Corps Enterprise Network and COC infrastructure, and make informed decisions on the subject. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37735

Keywords: IT, information technology, Wi-Fi, Marine Corps, Combat Operations Center, COC CapSets, wireless, budgets

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MASTER OF SCIENCE IN INFORMATION WARFARE SYSTEMS ENGINEERING

OPTIMIZATION OF PASSIVE COHERENT RECEIVER SYSTEM PLACEMENT

This thesis has been recognized as outstanding by its department.

Raymond Guethler IV–Lieutenant Commander, United States Navy
Master of Science in Information Warfare Systems Engineering
Advisor: Phillip Pace, Department of Electrical and Computer Engineering
Co-Advisor: Patrick Ford
Second Reader: Edward Fisher, Department of Information Sciences

Passive coherent receiver systems are a form of non-monostatic radar (NMR) that use active emitters of opportunity (digital television, cell phone systems, and other types of emissions) as a source of reflected target energy. These systems, used within both the military and public sectors, require specific information in order to be placed properly relative to emitters of opportunity and the desired area of detection/coverage. This thesis refines and presents a method of deriving optimal NMR placement, taking into account such variables as spreading loss and terrain data. This also includes optimal placement in a dynamic electromagnetic environment, when one or more of the emitters of opportunity cease transmission/are shut down for maintenanc. The majority of the modeling utilizes Matrix Laboratory (MATLAB) to generate signal strength plots, which can be applied toward predicting the optimal location for passive receiver placement, as well as where detection hole/voids may be present. MATLAB was used to model the signal-to-noise ratios presented by varying the number and location of receivers. These simulations provide an analytic means to estimate the optimal placement of assets to maximize coverage for a particular geographic area. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37634

Keywords: multi-static radar, passive coherent receiver, optimized placement, terrain data, detection area, emitters of opportunity

PSEUDORANDOM NUMBER GENERATORS FOR MOBILE DEVICES: AN EXAMINATION AND ATTEMPT TO IMPROVE RANDOMNESS

This thesis has been recognized as outstanding by its department.

Ola Larsson–Major, Swedish Army
Master of Science in Information Warfare Systems Engineering
Master of Science in Applied Mathematics
Advisor: Pantelimon Stanica, Department of Applied Mathematics
Co-Advisor: Zachary Peterson, Department of Computer Science
Second Reader: Raymond Buettner, Department of Information Sciences

This thesis examines the quality of pseudorandom number generation for cryptographic purposes in general and the generation of such numbers in a mobile device (Android phone), in particular, since we expected to find non-random properties in these. Initially, the need for random numbers for encryption purposes is discussed from a perspective of Information Warfare. Thereafter, ways of testing a bit string for random properties as well as some pseudorandom number generating algorithms are presented. This also includes the shrinking and the self-shrinking generator normally used to improve the random properties of the output m-sequence of linear feedback shift registers. A couple of possible attacks on pseudoran-

dom number generators are also briefly presented. Finally, we generate and analyze some pseudorandom bit strings in three different ways using the NIST test suite, both before and after the self-shrinking generator has been applied to them. The strings generated by the Android phone passed the NIST test suite, and it is difficult to claim any improvement in random properties by applying the self-shrinking generator. On a bit string with poor random properties, however, the self-shrinking generator improves randomness from the perspective of linear dependency and complexity but not from the perspective of bit frequency. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37657

Keywords: pseudorandom number generator, PRNG, random number, random bit, self-shrinking generator, SSG, encryption, mobile device, android

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

NOSE FAIRING MODELING AND SIMULATION TO SUPPORT TRIDENT II D5 LIFECYCLE EXTENSION

Robert Blanchard–Lieutenant, United States Navy
Master of Science in Mechanical Engineering
Advisor: Ramesh Kolar, Department of Systems Engineering
Second Reader: Fotis Papoulias, Department of Systems Engineering

The objective of this thesis is to evaluate a modeling and simulation tool for the analysis of the Trident II D5 missile nose fairing to determine the limitations of serviceability through the extended service life of the D5 missile. The benefit of this analysis is a means to evaluate and manage the remaining nose fairing supply and serve as a baseline for future production of nose fairings. Constructed of a Sitka spruce and fiberglass laminate, the nose fairing is designed as the lifting point of the missile for submarine onloads and offloads and supports the entire weight of the missile. A computer model of the nose fairing was used to evaluate the nose fairing under tensile and compressive loading conditions to simulate the lifting evolution and closure segment impact at time of launch. Changes in the material properties of the model allow for a simulation of aging in the nose fairing to estimate the performance degradation over time, as well as exploration of the applicability of new materials to any future design of nose fairings. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37588

Keywords: Trident II D5, composites, nose fairing, ANSYS, modeling and simulation

DEVELOPMENT AND VALIDATION OF A CONTROLLED VIRTUAL ENVIRONMENT FOR GUIDANCE, NAVIGATION AND CONTROL OF QUADROTOR UAV

Junwei Choon–Civilian Engineer, Singapore Technologies Aerospace
Master of Science in Mechanical Engineering
Advisor: Oleg Yakimenko, Department of Systems Engineering
Co-Advisor: Isaac Kaminer, Department of Mechanical and Aerospace Engineering

This thesis is focused on the development of a six degrees of freedom (6DOF) simulation model of a commercial-off-the-shelf quadrotor. The dynamics of the quadrotor and its control strategy are described. The Geometric Dilution of Precision of the Autonomous Systems Engineering and Integration Laboratory used in conducting the experiments is also analyzed. Simulation results are then verified with actual flight data. A direct method of calculus of variations is employed in the development of an algorithm for optimal trajectory generation and collision-free flight. Using the differential-flatness characteristics of the system, the trajectory optimization is posed as a nonlinear constrained optimization problem in the virtual domain, not explicitly related to the time domain. Appropriate parameterized functions employing an abstract argument, known as the virtual arc, are used to ensure initial and terminal constraints satisfaction. A speed factor maps the virtual to the time domain and controls the speed profile along any predetermined trajectory. An inner loop attitude controller was used to achieve almost global asymptotic attitude tracking for trajectory following. The trajectory generation and follow-

ing algorithms were verified using the 6DOF simulation model through a simulated collision avoidance scenario. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37600

Keywords: quadrotor, Qball, six degrees of freedom, 6DOF model, proportional integral derivative, PID, direct methods, trajectory, optimization, inverse dynamics, inverse dynamics In virtual domain, IDVD, collision avoidance

INCREASING SLEW PERFORMANCE OF REACTION WHEEL ATTITUDE CONTROL SYSTEMS

This thesis has been recognized as outstanding by its department.

Steven Crews II–Major, United States Army
Master of Science in Mechanical Engineering
Master of Science in Astronautical Engineering
Advisor: Mark Karpenko, Department of Mechanical and Aerospace Engineering
Co-Advisor: Isaac Ross, Department of Mechanical and Aerospace Engineering

This thesis explores the physical and mathematical limitations of two common attitude control systems: one based on reaction wheels and another based on control moment gyroscopes (CMGs). The dynamics are derived from first principles, and control algorithms for achieving maximum reaction wheel potential are discussed. The shaped eigenaxis input is utilized to establish baseline maneuver performance. A time-optimal shaped input is introduced and implemented in a feedback setting, subject to the limitations of the Moore-Penrose pseudo-inverse control allocation. Finally, a feed-forward plus feedback controller is introduced to implement the time-optimal torque inputs directly to the reaction wheels. This obviates the need for the pseudo-inverse control allocation, and therefore exploits the total capacities of both the reaction wheel momentum envelope and torque envelope. These reaction wheel control approaches are compared with CMG performance to establish spacecraft size and slew parameters that make the use of reaction wheels a reasonable choice See full thesis text: https://calhoun.nps.edu/public/handle/10945/37606

Keywords: reaction wheel, control moment gyroscope, CMG, momentum envelope, torque envelope, optimization, optimal control, pseudo-inverse, DIDO, scaling, effective eigenaxis, reaction wheel advantage angle

EXPERIMENTAL AND COMPUTATIONAL ANALYSIS OF A MINIATURE RAMJET AT MACH 4.0

Bryant Giorgi–Ensign, United States Navy
Master of Science in Mechanical Engineering
Advisor: Garth Hobson, Department of Mechanical and Aerospace Engineering
Second Reader: Christopher Brophy, Department of Mechanical and Aerospace Engineering

A miniature ramjet engine designed to perform at Mach 4.0 was tested in a supersonic wind tunnel. Cryogenic strain gauges were used to measure drag, and Schlieren imaging techniques were used to observe the inlet Mach cone profile at Mach numbers of 4.0. Three different nozzle configurations were tested to confirm computational models used to predict back pressure and normal shock locations at the inlet. Using ANSYS-CFX, a cold flow, computational fluid dynamics model of the ramjet in the wind tunnel was evaluated to compare with the experimental results. This model was then used as a base for an eddy dissipation combustion model. Hydrogen was modeled as being injected into the combustion chamber of the ramjet through inlet struts and then reacting with atmospheric oxygen to produce combustion. Drag predictions were inconclusive; however, the computational model remained stable during combustion calculations. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37632

Keywords: Mach 4, ramjet, drag, turbulence modeling, simulation, ANSYS CFX

NUMERICAL ANALYSIS OF ICE IMPACTS ON AZIMUTH PROPELLER

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Master of Science in Mechanical Engineering
Advisor: Young Kwon, Department of Mechanical and Aerospace Engineering
Co-Advisor: Jarema Didoszak, Department of Mechanical and Aerospace Engineering

Incorporating an azimuth/podded propulsion into an ice-capable ship brings concern in the propellers durability and lifecycle. An ice impact model was constructed to have a better understanding of collisions occurring between ice and azimuth/podded propeller for ice operation ships. A typical propeller profile was created using MATLAB and modeled in SolidWorks using realistic material properties. The ANSYS Explicit Dynamics solver was used to simulate the ice-propeller impact. By conducting a parametric study, the ice impact model displayed situations and instances to avoid shortening the use of propellers in ice operation. Therefore, using the ice impact model will allow further study to provide better understanding of the collision a piece of ice has on a propeller. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37649

Keywords: ice impact, azimuth propeller, explicit dynamics

DYNAMIC RESPONSE OF COMPOSITE STRUCTURES UNDERWATER

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Second Reader: Jarema Didoszak, Department of Mechanical and Aerospace Engineering

This paper presents a comparison of the dynamic response of composite structures that are subjected to low velocity impacts while being both suspended in air and submerged in water. As the U.S. Navy continues to use larger composite components in the construction of their ships, an understanding of the effect of submergence in water (i.e., fluid-structure interaction) on various locations of the structures can be instrumental in the design process of ship components. To better understand the responses at varying locations due to fluid-structure interaction, a composite plate was made with several strain gages affixed in one quadrant. The plate was then subjected to increasing impact forces while suspended in air, as well as being submerged in water. Additionally, a beam sample was also tested under the same conditions, with strain gages being affixed in-line with the impact rod. By comparing the strain gage responses between the open air and submerged samples, a better understanding of the magnitude of the fluid structure interaction is achieved, identifying critical locations in the samples that are most likely to fail. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37704

Keywords: composite, fluid structure interaction, impact testing

DIVER RELATIVE UUV NAVIGATION FOR JOINT HUMAN-ROBOT OPERATIONS

Andrew Streenan–Lieutenant, United States Navy
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Advisor: Noel Du Toit, Department of Mechanical and Aerospace Engineering
Second Reader: Doug Horner, Department of Mechanical and Aerospace Engineering

A novel application for autonomous underwater vehicles is considered here: a robotic diver assistant that enables close-quarters robotic operations with human divers. A robotic diver assistant has the potential to improve the efficiency, effectiveness, and safety of diver operations. The robot diver assistant must share the operating environment with human divers, navigate relative to the environment to reach a specified site location (along with moving divers), and then maneuver among the mostly static divers as they perform their tasks

on location. The robot operates in three unique scenarios: station-keeping, diver-following (shadowing), and diver-leading (vectoring). Various strategies for navigating among divers while ensuring diver safety are investigated. A reactive strategy, based on potential fields, is investigated and applied to station-keeping and diver-following. A deliberative approach, which plans the robots motion over a finite horizon, is presented for diver leading. These approaches are applied to the SeaBotix vLBV300 platform, for which a simulator is developed based on a decoupled motion model for the platform, as well as experimental results in a controlled test tank. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37726

Keywords: unmanned underwater vehicle, UUV, tethered, hovering, autonomous underwater vehicle, AUV, joint human-robot operations, dynamic, uncertain environments

REAL-TIME DYNAMIC MODEL LEARNING AND ADAPTATION FOR UNDERWATER VEHICLES

Joshua Weiss–Lieutenant, United States Navy
Master of Science in Mechanical Engineering
Advisor: Noel Du Toit, Department of Mechanical and Aerospace Engineering
Second Reader: Douglas Horner, Department of Mechanical and Aerospace Engineering

Precision control of unmanned underwater vehicles (UUVs) requires accurate knowledge of the dynamic characteristics of the vehicles. However, developing such models is time and resource intensive. The problem is further exacerbated by the sensitivity of the dynamic model to vehicle configuration. This is particularly true for hovering-class UUVs, since sensor payloads are often mounted outside the vehicle body. Methods are investigated in this thesis to learn the dynamic model for such a hovering-class UUV in real time from motion and position measurements. Several system identification techniques, including gradient estimation, Bayesian estimation, neural network estimation, and recursive linear least square estimation, are employed to estimate equations of motion coefficients. Experimental values are obtained for the surge, sway, heave, and yaw degrees of freedom. Theoretical results are obtained for the roll and pitch degrees of freedom. The experimentally obtained model is then compared to the true vehicle behavior. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37741

Keywords: unmanned underwater vehicles, UUVs, system identification, hydrodynamic model, online model learning, autonomous underwater system

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

PHYSICAL PROCESSES IN COASTAL STRATOCUMULUS CLOUDS FROM AIRCRAFT MEASUREMENTS DURING UPPEF 2012

Pamela Tellado–Lieutenant Commander, United States Navy
Master of Science in Meteorology and Physical Oceanography
Advisor: Qing Wang, Department of Meteorology
Second Reader: Wendell Nuss, Department of Meteorology

The objective of this thesis was to perform the initial analysis of aircraft measurements from the field campaign of the Unified Physical Parameterization for Extended Forecast. We examined the general characteristics of the observed stratocumulus-topped boundary layers and identified cases for future in-depth studies. We first determined the boundary layer heights from all sounding profiles. The results indicated the sharp westward increase of boundary layer height is limited to ~200 km offshore with an average slope of 2m per kilometer. Substantial west-east spatial variability of thermodynamic properties is also observed from vertical profiles. The sea surface temperature (SST) in the region varied significantly. Near surface measurements over the warm and cold SST regions for three cases were analyzed and compared. This research found that the small scale variability in the SST resulted in significant variation in the surface exchange of sensible and latent heat fluxes, and wind stress. Such variability makes it difficult to correctly parameterize surface fluxes. The presence of cool downdrafts in the upper cloud layer is evident in the joint probability density distribution and buoyancy flux profiles. The results from this research will guide future cloud parameterization scheme development in forecast models. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37729

Keywords: stratocumulus clouds, Marine Boundary Layer, Unified Physical Parameterization for Extended Forecast, UPPEF 2012, aircraft measurements, sea surface temperature, SST front

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MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION

INTEGRATING UNMANNED AERIAL VEHICLES INTO SURVEILLANCE SYSTEMS IN COMPLEX MARITIME ENVIRONMENTS

This thesis has been recognized as outstanding by its department.

Georgios Dimitriou–Lieutenant Commander, Hellenic Navy
Master of Science in Modeling, Virtual Environments, and Simulation
Advisor: Quinn Kennedy, Department of Operations Research
Second Reader: Thomas Lucas, Department of Operations Research

One of the most important missions all navies have is to constantly and sufficiently monitor their area of responsibility. This task becomes more challenging when a surveillance system operates in a complex environment with high traffic of merchant and fishing vessels and the existence of many islands. Potential tactics that targets might use increase the difficulty of this task. Integrating unmanned aerial vehicles (UAVs) into a surveillance system that consists of ground radars and surface ships might enhance the systems capabilities and mitigate its vulnerabilities. In this study, the extremely complex maritime environment of the Aegean Sea is modeled in the Map Aware Non-Uniform Automata (MANA) agent-based simulation environment to explore the effectiveness of UAVs in those conditions. The results from almost 100,000 simulated Intelligence, Surveillance, and Reconnaissance missions are analyzed using descriptive statistics, ANOVA, stepwise regression, and partition trees. It was found that by integrating one or two UAVs into a traditional surveillance system, it becomes more efficient in the detection and persistent surveillance of enemies and neutral targets. The most important factors that affect the surveillance systems' performance are the detection capabilities of its sensors, the communication accuracy, and the enemy's counter-detection capability. Thus, Greece and other countries with similar geographical characteristics should deploy UAVs in a maritime surveillance role. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37613

Keywords: agent-based modeling, unmanned aerial vehicle, UAV, design of experiment, Maritime Intelligence Surveillance and Reconnaissance, Map-Aware Non-Uniform Automata, MANA

UNTRAINED FORWARD OBSERVER (UFO) TRANSLATOR FOR CALL FOR FIRE

Regan King–Captain, United States Marine Corps
Master of Science in Modeling, Virtual Environments, and Simulation
Advisor: Gurminder Singh, Department of Computer Science
Co-Advisor: John Gibson, Department of Computer Science

Many observers need indirect fire but are not proficient in Call for Fire, the procedure used to request indirect fire. To alleviate this, we propose the development of an application, which we call the Untrained Forward Observer (UFO) Translator, capable of assisting untrained observers in performing Call for Fire by asking a series of simple questions to generate a Call for Fire in the proper format. As a prior Forward Observer with more than 12 years of Call for Fire experience, and as a former Supporting Arms instructor at the Basic School in Quantico, Virginia, I have carefully designed the application outlined in this thesis to ensure the logic in place is sufficient and appropriate to retrieve the required information from users to generate a proper Call for Fire capable of executing a fire mission utilizing indirect fire. A prototype of the application was tested and partially verified in a pilot study conducted at the Naval Postgraduate School and discussed herein. I believe the UFO Translator will fulfill its design specifications and be easy enough to use by any military member,

regardless of rank, billet, or experience. In this thesis, I present the design and layout of the UFO Translator. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37651

Keywords: Call for Fire, artillery, mortars, fire mission, Forward Observer, tactical fire support

VIRTUAL ENVIRONMENT TRAINING ON MOBILE DEVICES

This thesis has been recognized as outstanding by its department.

James Reynolds–Major, United States Marine Corps
Craig Smith–Major, United States Marine Corps
Master of Science in Modeling, Virtual Environments, and Simulation
Advisor: Joseph Sullivan, MOVES Institute
Second Reader: Erik Johnson

Over 100 million tablet computers have been sold in the last three years. They now have the computing power of a state-of-the-art laptop of just a few years ago. This computing power and market saturation allows them to become viable virtual environment (VE) trainers. Tablets have a different set of input modalities and user expectations that need to be taken into careful consideration when a VE trainer is designed. The authors developed a VE Call for Fire (CFF) trainer and explored the processes necessary to make it successful. In order to utilize tablet hardware to its full potential, the authors devised the Window to the World (W2W) paradigm as it applies to a mobile device. The authors' tablet CFF trainer, Supporting Arms TrainerMobile (SAT-M), was compared to the Marine Corps current laptop CFF system, ObserverSim. Despite being in early development, participants with and without CFF experience overwhelmingly preferred SAT-M ($p=0.002$). Reasons included the ability of W2W to mimic real world physical motion, an easier to use interface, and a decrease in extraneous cognitive load. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37700

Keywords: virtual environment, mobile, tablet, simulation, training, Call for Fire, window to the world

DEVELOPING BEHAVIORAL METRICS FOR DECISION-MAKING IN MARINE CORPS SMALL-UNITS

Jonathon Richardson–Captain, United States Marine Corps
Master of Science in Modeling, Virtual Environments, and Simulation
Advisor: Susan Hutchins, Department of Information Sciences
Co-Advisor: Lee Sciarini, Department of Operations Research
Second Reader: Quinn Kennedy, Department of Operations Research

This thesis developed behaviorally anchored-rating scales (BARS) for use in evaluating Marine Corps small-units (SUs) during live and virtual decision-making (DM) training. Currently, the Marine Corps does not mandate the use of standardized metrics and processes for the evaluation and feedback during SU DM training scenarios. Often, evaluators assess trainee performance in uncertain situations based on gross outcomes rather than process-oriented measures. Properly developed and integrated into a training plan, BARS offers a novel solution to these constraints. The application of BARS has been explored in the law enforcement and medical domains and has been explored on a limited basis for infantry tasks. This effort proposed that observing SU leaders' observable behaviors in context of their task performance would provide objective measures of DM. The first portion of this work was focused on the design and development of BARS specific for use during multiple Infantry Immersion Trainer (IIT) scenarios. The second phase of this research refined the initial BARS into six scenario-specific evaluation measurement tools. Additionally, this work provided an initial effectiveness evaluation of the refined BARS in operational training at the IIT. Results indicate that the BARS developed for this thesis have the potential to replace the nonstandard and subjective methods currently used for the evaluation of DM training in live and virtual environments. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37701

Keywords: decision-making, metrics, behaviorally-anchored rating scales, BARS, cognitive task analysis

ENHANCING ENTITY LEVEL KNOWLEDGE REPRESENTATION AND ENVIRONMENTAL SENSING IN COMBATXXI USING UNMANNED AIRCRAFT SYSTEMS

James Teters II–Major, United States Army
Master of Science in Modeling, Virtual Environments, and Simulation
Advisor: Imre Balogh, MOVES Institute
Second Reader: Peter Nesbitt

Current modeling and simulation techniques may not adequately represent military operations using unmanned aircraft systems (UAS). A method to represent these conditions in a combat model can offer insight to the use and application of UAS operations, as well as understanding the sensitivity of simulation outcomes to the variability of UAS performance. Additionally, using combat model simulations that do not represent UAS behavior and conditions that cause this variability may return misleading or incomplete results. Current approaches include explicit scripting of behaviors and events. We develop a proof of principle search, targeting, and acquisition (STA) model for use with UAS within COMBATXXI, leveraging existing STA research conducted at the MOVES Institute at the Naval Postgraduate School. These dynamic behaviors are driven by events as they unfold during the simulation run rather than relying on preplanned events as in the scripted approach. This allows these behaviors to be highly reusable since they do not contain scenario- or incident-specific information. We demonstrate the application of the new STA model in a tactical convoy scenario in COMBATXXI. A design of experiments and post analysis quantifies the sensitivity of the measures of effectiveness of success to conditions contributing to variability in UAS performance. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37732

Keywords: UAS, UAVs, unmanned aircraft systems, unmanned aerial vehicle, sensors, electronics & electronic warfare, information systems technology, COMBATXXI, HTNs, hierarchical task networks, ontology, reasoning, knowledge representation, training

DIFFUSION AND LARGE-SCALE ADOPTION OF COMPUTER-SUPPORTED TRAINING SIMULATIONS IN THE MILITARY DOMAIN

Floy Yates Jr.–Major, United States Marine Corps
Master of Science in Modeling, Virtual Environments, and Simulation
Advisor: Amela Sadagic, MOVES Institute
Second Reader: Rudy Darken, Department of Computer Science

The focal point of this thesis is the overall process of diffusion and adoption of technological innovations (computer-supported training simulations) within the military domain. The goal was to capture the positive and negative trends that appear to be the most significant toward the adoption process. The approach selected in this thesis was to execute a user study and collect a set of data points concerned with the users' overall demographics, attitudes, expectations, knowledge, misconceptions, usage, advertising, leadership endorsement, and other elemental characteristics for adoption of those systems in the military domain. The data survey was conducted within MCAGCC, Twentynine Palms, California; it addressed specific needs of four different groups of users (Trainees, Unit Leadership, Trainers, and Base Leadership). The analysis of collected data sets demonstrated that diffusion and adoption of these types of solutions is a complex, multilayered problem that goes beyond the characteristics of the systems/tools. The summary of user profiles, attitudes toward technology, and other elements relevant to the training domain demonstrated that clearly. The findings in this work can be generalized to any other USMC base, and they have a universal value applicable to the adoption of computer-supported training simulations by other DoD services. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37746

Keywords: diffusion, innovation, technology, adoption, computer-supported, training, large-scale, modeling, simulation

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MASTER OF SCIENCE IN OPERATIONS RESEARCH

ALGORITHMS FOR EFFICIENT INTELLIGENCE COLLECTION

This thesis has been recognized as outstanding by its department.

Duncan Ellis–Lieutenant Commander, United States Navy
Master of Science in Operations Research
Advisor: Nedialko Dimitrov, Department of Operations Research
Second Reader: Moshe Kress, Department of Operations Research

Modern intelligence techniques have drastically increased the rate at which communications data can be intercepted. The increased ability to collect and store this data poses a significant processing problem for intelligence agencies. We develop a software library, implementing a previously developed mathematical model of the information selection problem facing these agencies: given a time constraint, which items should be screened in order to maximize the relevant information obtained. Using our software, we analyze the performance of several screening strategies on a variety of representative intercepted intelligence networks, which we construct using real-world data sets. We show that the model consistently outperforms more naive approaches on networks with clusters of relevant sources and highlight the importance of exploration in robust screening strategies. See full thesis text: https://calhoun.nps.edu/handle/10945/37621

Keywords: analysis of algorithms, intelligence collection, graphical models, Bayesian inference, Markov random fields, networks

MULTIVARIATE VISUALIZATION IN SOCIAL SCIENCES AND SURVEY DATA

William Evans–Lieutenant Commander, United States Navy
Master of Science in Operations Research
Advisor: Ronald Fricker, Department of Operations Research
Second Reader: Samuel Buttrey, Department of Operations Research

For presentation of survey results, social science data and other geospatial statistics require careful attention in order to facilitate fast and accurate interpretation. Adding dimensionality can easily saturate the observer, leading to confusion instead of adding perspective. We produce over a dozen techniques to facilitate multivariate geospatial visualization, filter them with pilot groups, and then design a computer-based human experiment to evaluate their relative performance. In the experiment, the participants locate (with a mouse click) regions with extreme primary or secondary values and then later estimate numerically the values of these variables. We analyze these data with linear and logistic regression and general additive models to characterize the variance due to a learning effect, then use general linear mixed-effects models to block out the variability due to individual participants and the independent and randomly-generated survey data used to generate the experiment plots. The effectiveness of a particular technique depends heavily on the goal of the presentation: a technique that provides relative perspective without distracting from the primary variable may not facilitate estimation that is as accurate as other techniques. Four scenarios are provided to qualify the presenters' intent. Only one technique performed poorly in all four scenarios, and only one technique was average in all four; all remaining varied from very good to very bad between scenarios. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37623

Keywords: general linear model, GLM, general additive model, GAM, general linear mixed-effects model, GLMM, multivariate, visualization, survey, social science, geospatial, experiment, multidimensional

ASSESSING AND MINIMIZING ADVERSARIAL RISK IN A NUCLEAR MATERIAL TRANSPORTATION NETWORK

Bradford Foster–Lieutenant, United States Navy
Master of Science in Operations Research
Advisor: R. Kevin Wood, Department of Operations Research
Second Reader: Kyle Lin, Department of Operations Research

This thesis develops a simple method for evaluating adversarial risk within the transportation portion of the nuclear fuel cycle for commercial electric power generation and develops models that can guide the reduction of that risk by such means as rerouting and decoy shipments. A conceivable, worst-case attack by an intelligent adversary will cause a localized release of radioactive material. A damage function is defined using the population in the vicinity of the attack. Using hypothetical but realistic transit routes between fuel fabricators and power plants, we identify the worst-case locations for attack. Then, we formulate and solve mixed-integer programs to either (1) redesign the network by changing supply contracts, or (2) optimally allocate a resource-constrained assignment of decoy shipments. We also demonstrate a greedy procedure for simple rerouting of individual shipments. Computational methods exploit standard geographical databases, and optimization software solves the models in seconds on a personal computer. Separate but similar analyses would apply to shipments of uranium hexafluoride, spent fuel being shipped for reprocessing, spent fuel being shipped to a repository, and other materials. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37629

Keywords: nuclear material, hazmat, transportation network, adversarial risk, mixed integer programming, decoy

IMPROVING THE ARMY'S JOINT PLATFORM ALLOCATION TOOL (JPAT)

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Master of Science in Operations Research
Advisor: Emily Craparo, Department of Operations Research
Second Reader: Christopher Marks, United States Army

The U.S. Army's joint platform allocation tool (JPAT) is an integer linear program that was developed by the Army's Training and Doctrine Command Analysis Center and the Naval Postgraduate School to help inform acquisition decisions involving aerial reconnaissance and surveillance (R&S) resources. JPAT evaluates inputs such as mission requirements, locations of available equipment, and budgetary constraints to determine an effective assignment of unmanned aerial R&S assets to missions. As of September 2013, JPAT is solved using a rolling horizon approach, which produces a sub-optimal solution and requires substantial computational resources to solve a problem of realistic size. Because JPAT is an integer linear program, it is a suitable candidate for using decomposition techniques to improve its computational efficiency. This thesis conducts an analysis of multiple approaches for increasing JPAT's computational efficiency. First, we reformulate JPAT using Bender's decomposition. Then, we solve both the original and decomposed formulations using the simplex and barrier algorithms with multiple size datasets. In addition, we experiment with an initial heuristic solution and other techniques in our attempts to improve JPAT's runtime. We find that while Benders decomposition does not result in significant improvements in computation time for the instances considered in this thesis, initial solution heuristics and other modifications to the model improve JPAT's performance. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37635

Keywords: joint platform allocation tool, JPAT, Benders decomposition, mixed integer program, MIP

THE OPTIMAL EMPLOYMENT AND DEFENSE OF A DEEP SEAWEB ACOUSTIC NETWORK FOR SUBMARINE COMMUNICATIONS AT SPEED AND DEPTH USING A DEFENDER-ATTACKER-DEFENDER MODEL

Andrew Hendricksen–Lieutenant, United States Navy
Master of Science in Operations Research
Advisor: W. Matthew Carlyle, Department of Operations Research
Co-Advisor: Joseph Rice, Department of Physics
Second Reader: Robert Burks, Department of Defense Analysis

The need for submarines to execute communications at speed and depth (CSD) is a vital link in our nation's and our allies' defense network. A promising method to do this without limiting the inherent stealth and advantage of submarines is to utilize Deep Seaweb, an underwater acoustic communication network. The challenge is to be able to optimally employ such a network in a constantly changing environment. In particular, our goal is to develop a network that is resilient to a given number of adversary attacks that can disable individual nodes. To this end, we build and solve a defender-attacker-defender optimization model that provides the optimal location of repeater nodes that maintains as much of the function of the network as possible, even after a worst-case attack. We analyze four initial basic network configurations and compare the resulting optimum node placements when the network is not subject to attack, when the network is subject to two attacks, and when the flow of each network configuration is completely blocked by attacks. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37637

Keywords: defender-attacker-defender, DAD, dual-integer linear program, DILP, attacker-defender, AD, subproblem, network optimization, tri-level optimization, communications networks, sensor networks, network design, network interdiction, undersea distributed networks, seaweb, submarine communications at speed & depth, CSD, ocean acoustics, acoustic communications, Acomms, FORCEnet, deep sound channel, DSC

EFFECTS OF DOD ENGAGEMENTS IN COLLABORATIVE HUMANITARIAN ASSISTANCE

James Robert Koffi–Lieutenant, United States Navy
Master of Science in Operations Research
Advisor: Samuel Buttrey, Department of Operations Research
Second Reader: Deidre McLay, United States Navy

This thesis analyzes long-term effects of Department of Defense measures of effectiveness (MOE) and measures of performance for humanitarian assistance (HA) missions. The Overseas Humanitarian Assistance Shared Information System (OHASIS) is used as the primary data source for HA missions and its associated costs. The thesis centers on HA missions in countries within the Pacific Command area of responsibility eligible for HA funding as described in U.S. Code Title X. An assumption of endogeneity is made regarding the data and a two-stage least squares (2SLS) fixed effects model is used as an alternative method to ordinary least squares (OLS) for analysis. The number of bilateral agreements between the United States and HA host nations serves as an instrumental variable. The United Nations Human Development Index (HDI) is the MOE. Analysis shows that an OLS model is preferred over a 2SLS for this dataset. The effect of HA expenditures is significant and positive, indicating that increased HA expenditures are associated with higher levels of the HDI. The proportion of population with access to potable water is significantly positively associated with HDI in the model, suggesting that increasing the number of HA water projects might be one strategy for increasing HDI. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37653

Keywords: OHASIS, Overseas Humanitarian Assistance Shared Information System, humanitarian assistance, Human Development Index, two-stage least squares, endogeneity

OPTIMIZING ADVERSARY TRAINING AND THE STRUCTURE OF THE NAVY ADVERSARY FLEET

This thesis has been recognized as outstanding by its department.

J. Ryan McLaughlin–Lieutenant Commander, United States Navy
Master of Science in Operations Research
Advisor: Robert Dell, Department of Operations Research
Co-Advisor: W. Matthew Carlyle, Department of Operations Research
Second Reader: Jeffrey Hyink, Department of Operations Research

Simulation of threat aircraft tactics and capabilities during training is an integral component of maintaining the combat readiness of the United States Navy. A dedicated adversary air force supports the majority of adversary training missions, but these airframes are aging and lack the sortie generation capacity and performance capabilities to completely satisfy the training requirements. The Navy currently uses other opposition forces to fill the gap between the adversary air force capacity and the demand for training. This training gap will grow over the next decade as current airframes reach their flight hour limits, and, as resources become scarcer, the task of determining efficient assignment of these resources becomes more difficult for planners, and the resulting solutions are more expensive than necessary. This thesis presents the Adversary Sortie Optimization Tool, which uses an integer-linear program to optimize the assignment of adversary air sorties to meet the annual fleet training demands over a 20-year planning horizon and prescribes yearly upgrades to the adversary air force, including procurement of performance enhancing aircraft pods, improved radar, new aircraft, and system upgrades. Solutions provide a reduction in operating costs of hundreds of millions of dollars using efficient sortie assignment, aircraft and system upgrades, and managing the home base location of aircraft. These savings are achieved while also improving the quality of training and saving valuable hours on fleet aircraft. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37674

Keywords: optimization, integer-linear program, United States Navy, adversary, strikefighter squadron, aviation, air combat, training, readiness

LIFE-CYCLE COST MODELING TO DETERMINE WHETHER VEHICLE-TO-GRID (V2G) INTEGRATION AND ANCILLARY SERVICE REVENUE CAN GENERATE A VIABLE CASE FOR PLUG-IN ELECTRIC DRIVE VEHICLES

Joseph Monahan–Captain, United States Marine Corps
Master of Science in Operations Research
Advisor: Daniel Nussbaum, Department of Operations Research
Second Reader: Alejandro Hernandez, Department of Systems Engineering

In an effort to increase U.S. energy security by reducing oil consumption, various federal mandates and executive orders require reduced petroleum use and greenhouse gas emissions by federal non-tactical vehicle fleets. Transitioning federal fleets to plug-in electric drive vehicles (PEDVs) is one option to meet these mandates. This research performs a life-cycle cost analysis using modeling and simulation to determine the parameters under which vehicle-to-grid (V2G) integration and associated revenue streams can create a viable economic case for the transition of federal fleets to PEDVs. Under current market conditions, bidirectional V2G frequency regulation (FR) is not currently viable. Unidirectional FR has potential, but it provides minimal reductions in PEDV life-cycle cost. The cost to meet petroleum reduction mandates by transitioning light-duty fleets to PEDVs is cost prohibitive and impractical, requiring almost a complete one-for-one replacement of the current fleet of traditional light-duty passenger vehicles. Realistically meeting the mandate without fleet downsizing will require implementing a transition toward alternatively fueled vehicles beyond the light-duty passenger vehicle class. However, economic justification will require a reduction in PEDV acquisition costs or improved market conditions for V2G FR (consisting of lower through-

put and higher regulation market clearing prices) thereby resulting in considerably greater net revenue. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37678

Keywords: life-cycle cost analysis, vehicle to grid, V2G, energy modeling, ancillary services, frequency regulation, plug-in electric drive vehicles, hybrid electric vehicles, alternatively fueled vehicles, AFV, federal petroleum reduction mandates, energy independence, electrical grid, alternative energy solutions

A PROBABILISTIC MODEL OF ILLEGAL DRUG TRAFFICKING OPERATIONS IN THE EASTERN PACIFIC AND CARIBBEAN SEA

Matthew Mooshegian–Lieutenant Commander, United States Navy
Master of Science in Operations Research
Advisor: Michael Atkinson, Department of Operations Research
Second Reader: Johannes Royset, Department of Operations Research

Illicit drug-trafficking is a major concern of the United States and is a primary pillar of President Barack Obama's Strategy to Combat Transnational Organized Crime. In the eastern Pacific and Caribbean Sea, drug-trafficking organizations operate a variety of vessels to transit drugs from South America to the United States. Joint Interagency Task Force (JIATF) South, in cooperation with partner agencies and nations, detects, tracks, and interdicts illegal drug-trafficking in this region. In this thesis, we develop a probability model based on intelligence inputs to generate a spatial temporal heat map specifying the likely location of targets over time. We also formulate a path-finding model that takes the heat map as input and determines route characteristics through transit, such as departure times, waypoints, and speed. We link the results of our models to a separate effort that seeks to provide JIATF South with an optimal search plan to maximize the expected amount of drugs seized. We show that our path-finding model accurately reproduces the target's track even when the target transits along a complex route. Furthermore, we show that the optimal search plan based on our path-finding model is nearly identical to the search plan using the known parameters. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37681

Keywords: multivariate adaptive regression splines, MARS, linear regression, heat map, path-finding model, probability model, drug-trafficking, route estimation

MEASURING THE IMPACT OF BUSINESS RULES ON INVENTORY BALANCING

Andrew Oswald–Lieutenant Commander, Supply Corps, United States Navy
Master of Science in Operations Research
Advisor: Michael Atkinson, Department of Operations Research
Co-Advisor: Geraldo Ferrer, Graduate School of Business and Public Policy
Second Reader: Walter DeGrange, Department of Operations Research

Naval Supply Systems Command recently employed the Navy Enterprise Resource Planning Single Supply Solution to improve efficiency through the sharing of data across the organization. For the first time, replenishment decisions were made using shared enterprise data. Since all items from all sites are in one central database, Weapon Systems Support has total visibility of assets across all available supply sources. Inventory balancing is a promising functionality for enhancing the performance of inventory systems. With a balancing policy in place, stock can be moved from a location that has excess inventory to another location experiencing a shortage. The purpose of this movement of materiel is to reduce inventory costs and increase the percentage of demand satisfied by on-hand stock. This paper compares the relative effectiveness of different balancing business rules. A simulation model comprising a two-echelon supply network with three warehouse locations is used to evaluate the various business rules for several items with varying unit prices and demand frequencies. Although no single balancing policy is optimal in all situations, simple modifications

to the proposed business rules will increase the benefits of balancing while minimizing any negative effects. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37689

Keywords: inventory balancing, simulation, supply chain management, inventory control, lateral transshipment, spare parts, inventory pooling, Navy Enterprise Resource Planning

HEURISTIC ROUTE GENERATION FOR THE NAVY MISSION PLANNER

Benjamin Pearlswig–Lieutenant, United States Navy
Master of Science in Operations Research
Advisor: W. Matthew Carlyle, Department of Operations Research
Second Reader: Jeffrey Kline, Department of Operations Research

Navy Mission Planner is a decision support tool for operational planning at the theater level. It takes as input a scenario defined by a list of ships and their (multi-mission) capabilities, a list of missions to be accomplished, their values to a commander, their locations, and a fixed time horizon. It produces as output an employment schedule consisting of a route plan and a set of missions to accomplish for each ship on each day in the scenario. It attempts to maximize the total value of missions covered in the scenario by utilizing each ship to the best of its capabilities while balancing the geographic distribution of missions, the limited capability of the ships, and the limited time horizon. Prior versions used a limited enumeration routine to generate a manageable number of routes for each ship. We develop a heuristic route generator that reduces the runtime and provides better starting routes, improving the overall quality of solutions obtained by Navy Mission Planner. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37690

Keywords: Navy Mission Planner, NMP, heuristic, path generation, operational planning

ANALYSIS OF DECISIONS MADE USING THE ANALYTIC HIERARCHY PROCESS

Matthew Tabar–Lieutenant Commander, United States Navy
Master of Science in Operations Research
Advisor: Jeffrey Appleget, Department of Operations Research
Second Reader: Ronald Fricker, Department of Operations Research

This thesis analyzes the use of the analytic hierarchy process (AHP) as a decision-making tool. The analysis shows what information can be gained about a military decision-maker who uses the AHP, and how this information can be utilized, permitting U.S. and allied forces to execute efficient and effective military operations. A case study of the AHP decision-making process demonstrates techniques that can be used to garner information about the decision-maker and potentially influence their future decisions. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37727

Keywords: analytic hierarchy process, AHP, decision making, mirror imaging

A REVOLUTIONARY APPROACH FOR THE DEVELOPMENT OF FUTURE GROUND COMBAT SYSTEM SPECIFICATIONS

This thesis has been recognized as outstanding by its department.

Tobias Treml–Major, German Army
Master of Science in Operations Research
Advisor: Thomas Lucas, Department of Operations Research
Second Reader: Eugene Paulo, Department of Systems Engineering

This thesis provides a new specification development process for ground combat vehicles (GCVs). The most recent development programs for such a vehicle class failed due to extensive cost overruns. The author uses agent-based simulation to model and study the impacts of CGV capabilities in a most likely combat scenario according to the current threat assessment of the U.S. government. The most advanced modern weapon systems are used as a baseline performance, and extensive research is done to determine the state-of-the-art technologies available. These experimental technologies are then transferred to feasible ranges for specified performance factors for GCVs, such as engagement range, weapons lethality, armor, and mobility. Nearly orthogonal and space-filling designs are used to efficiently construct a response surface consisting of defined measures of effectiveness (MOEs) for GCVs. For each MOE, a meta-model is fitted that includes the most significant factors, interactions, and non-linarites. These models are then combined to find the most robust solution since a model will never exactly depict the real situation and a GCV will not be deployed in a scenario exactly like the one used in the study. The results of the meta-models will be used by the Department of Systems Engineering at the Naval Postgraduate School to create a dashboard for visualization of the tradeoff effects between performance factors. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37736

Keywords: agent-based, dashboard, design of experiment, GCV, ground combat vehicle, MANA , robust solution, specification process, simulation

A COMPARISON OF SLEEP AND PERFORMANCE OF SAILORS ON AN OPERATIONALLY DEPLOYED U.S. NAVY WARSHIP

Roger Young–Lieutenant, United States Navy
Master of Science in Operations Research
Advisor: Nita Shattuck, Department of Operations Research
Second Reader: Lyn Whitaker, Department of Operations Research

The crew's mission on a deployed warship is inherently dangerous. The nature of the job means navigating restricted waters, conducting underway replenishments with less than 200 feet of lateral separation from another ship, and various other operations all of which require a high level of training, alertness, and attention to detail. Performing these tasks when sailors are sleep-deprived creates the potential for catastrophic incidents that can cost millions of dollars and possibly result in injury or loss of life. This study compared the sleep and performance of sailors standing either the 3/9 or 6/6 watch rotation on a deployed warship. Results showed that not only did sailors standing the 6/6 rotation receive less sleep, but their response speeds were significantly slower than their 3/9 counterparts. Although the 3/9 participants stood half as much watch with twice as much time off watch, they still received only 391 minutes of sleep per night, on average. Even more concerning was that the 6/6 participants received only 330 minutes of sleep per night (less than six hours per day), on average, accruing over 2.5 hours of sleep debt per night. Sleep provides a combat edge to today's warfighters. Leaders neglect it at their peril. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37748

Keywords: sleep, fatigue, actigraphy, sleep deprivation, Navy Standard Workweek, NSWW, watch rotations, psychomotor vigilance test

COMBINING MULTIPLE TYPES OF INTELLIGENCE TO GENERATE PROBABILITY MAPS OF MOVING TARGETS

Philip Zlatsin–Captain, Israel Defense Forces
Master of Science in Operations Research
Advisor: Moshe Kress, Department of Operations Research
Co-Advisor: Michael Atkinson, Department of Operations Research
Second Reader: Nedialko Dimitrov, Department of Operations Research

Drug addiction in the United States generates significant health, economic, and social costs. One of the prominent ways in which traffickers smuggle drugs into the United States is by maritime shipments from South America. In 1989, Joint Interagency Task Force South (JIATF-S) was established to fight these traffickers. JIATF-S collects information from multiple sources, which can be broadly classified into two categories. The first category is sensor-based sources that produce observations about possible targets (e.g., radar and sonar). These observations provide precise location and time but are susceptible to false positive and false negative errors regarding their content. The second category is human-based sources, including tips, messages and intercepted communications among humans. In addition to possible misinformation regarding the content of an event, such inputs are also susceptible to errors regarding the location and time of the event. In this thesis, we develop a data fusion model that can assist JIATF-S in estimating the likelihood that a certain target (i.e., a drug-smuggling vessel) is present at a certain location at a certain time and evaluate the reliability of the information source. The novelty of this thesis is manifested in a new probabilistic approach for utilizing human-generated intelligence and in the way it is combined with sensor-generated intelligence. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37751

Keywords: intelligence cycle, intelligence processing, data fusion, Dempster-Shafer, HUMINT, SIGINT, Bayesian Update

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

THE EFFECTS OF INTERNAL TIDES ON ACOUSTIC PROPAGATION IN THE PHILIPPINE SEA

Weston Coby–Lieutenant, United States Navy
Jacob Fischer–Lieutenant, United States Navy
Master of Science in Physical Oceanography
Advisor: John Colosi, Department of Oceanography
Co-Advisor: Tarun Chandrayadula, Department of Oceanography

In 2009, a month-long study was conducted in the Western Philippine Sea. This experiment collected oceanographic and acoustic data from two moorings, the Distributed Vertical Line Array (DVLA) and T1 moorings. The T1 mooring used a 1,095m depth source to send broadband acoustic signals to DVLA receivers located between the depths of 800m and 1,385m. Jacob A. Fischer conducted the internal tide analysis presented in Chapter II. The oceanographic data were used to quantify the characteristics of internal tides in the sample area. Spectral analysis and mode fitting show that most of the energy within the internal tides is due to mode 1 of the tidal frequencies. Weston R.T. Coby conducted the acoustic analysis presented in Chapter III. The acoustic data were first used to identify acoustic timefronts across the observed depths, and track the timefronts arrivals. A ray prediction model was then used to match eigenray properties to the observed timefronts. Finally, the Viterbi program was used to track timefront arrivals and intensity for statistical analysis. Weston R.T. Coby and Jacob A. Fischer jointly compared the internal tide and acoustic variability presented in Chapter IV, proving internal tides significantly impact sound speed fluctuations in the Philippine Sea. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37627

Keywords: internal tides, acoustic propagation, Philippine Sea, ray modeling, internal tide model

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MASTER OF SCIENCE IN PROGRAM MANAGEMENT

IMPLICATIONS AND CONSTRAINTS OF FISCAL LAWS IN CONTINGENCY CONTRACTING

Angela Calhoun–Civilian, Department of the Army
Marcia Larssen–Civilian, Department of the Army
Master of Science in Program Management
Advisor: Philip Candreva, Graduate School of Business and Public Policy
Co-Advisor: Kristan Mendoza, Army Contracting Command-Rock Island
Co-Advisor: Amy Hayden, Army Contracting Command-Rock Island

When contracting officers procure goods and services to meet the needs of government agencies and programs, they seek best value and manage risk. Those government agencies must comply with fiscal laws while fulfilling their needs. Fiscal laws and regulations were originally designed for peacetime environments, processes, and systems. When unforeseen events occur and require an immediate response—such as a contingency environment mission—the regulatory framework is stressed. In a contingency environment, the constraints of fiscal laws and Federal Acquisition Regulations put contracting officers in the position of compromising mission results or compliance with the rules. This study examines cases where fiscal law constraints lead to either violation of the Antideficiency Act or impact to missions. We find that different contingency environments and phases of the contingency present different risks to mission effectiveness and compliance. We provide recommendations for more flexible funding and regulatory models in contingency environments. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37595

Keywords: fiscal law, contingency contracting, Antideficiency Act

WHY THE SURVIVABILITY ONION SHOULD INCLUDE RELIABILITY, AVAILABILITY, AND MAINTAINABILITY (RAM)

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Master of Science in Program Management
Advisor: Diana Petross, Graduate School of Business and Public Policy
Co-Advisor: Brad Naegle, Graduate School of Business and Public Policy

Reliability, availability, and maintainability (RAM) and survivability are both diverse disciplines that explore how a system will perform when placed within an operational environment. This joint applied project provides a qualitative analysis of the interconnectivity of RAM and survivability. It shows that an in-depth RAM analysis ensures that military personnel are better protected throughout the life cycle. Methodologies for improving reliability and maintainability are also presented, including physics of failure, highly accelerated life testing/highly accelerated stress screening, preventative maintenance determination, and pit stop engineering. This analysis uses an active protection system (APS) to show that when RAM is included in the Survivability Onion, both survivability and RAM evaluations benefit, survivability assessments become more complete, RAM assessments are completed sooner, and, ultimately, better systems are put into the hands of service members. As APS requirements are developed, it is important that they include the Materiel Availability Key Performance Parameter with associated Reliability and Ownership Cost Key System Attributes. When evaluating an APS (or any system), the independent evaluator team members need to integrate and discuss the impacts of the capabilities

and limitations they observed with each other to ensure that the deficiencies are properly addressed in the reports. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37614

Keywords: reliability, availability, and maintainability, RAM, scurvivability, test and evaluation, active protection systems

STANDARDIZATION IN PERFORMANCE ASSESSMENT OF TELEMETRY TRACKING SYSTEMS

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Advisor: Michael Boudreau, Graduate School of Business and Public Policy
Second Reader: Antonio Cardoso, Naval Surface Warfare Center

In the world of missile testing, telemetry plays a vital role in the evaluation of these weapon systems. Telemetry is defined as the process of taking measurements from a distance or a remote location. As measurements are made within the missile, the data is packetized and transmitted down to ground stations in real time. Once the data is accumulated, analysts review the data and evaluate the results of the missile test. Launching a missile is a major test event that requires significant coordination and a considerable amount of funding. Collecting as much data as possible is crucial and is always a fundamental requirement. Therefore, the telemetry tracking ground stations receiving the data play just as an important role as the missile itself. The ground stations must be reliable systems where periodic maintenance and technical refreshing are key elements in the risk management of the receiving system. This paper explores the effectiveness of predicting system failures by carefully analyzing antenna data metrics already made available to system users. By establishing a standard for evaluating these tracking systems, variances in the performance metrics over time may predict future system failures. By addressing potential issues preemptively, last-minute critical failures can be significantly reduced while making the systems availability and reliability much higher. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37667

Keywords: telemetry, tracking systems, performance assessment, system risk management

DEFENSE ACQUISITION WORKFORCE IMPROVEMENT ACT (DAWIA) CERTIFICATION: A COMPARATIVE ANALYSIS OF CERTIFICATION VERSUS QUALIFICATION

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Regina Bublitz–Civilian, Department of the Army
Master of Science in Program Management
Advisor: Brad Naegle, Graduate School of Business and Public Policy
Co-Advisor: Karon Curry, Defense Acquisition University

This project reflects extensive research on the Defense Acquisition Workforce Improvement Act (DAWIA) certification process. Project participants analyzed the processes currently employed by the Department of Defense (DoD) for civilian Army acquisition Program Managers and compared these processes to other services in relation to execution of the DAWIA certification process. Additionally, this project provides a comparative analysis of DAWIA compared to current DoD qualification initiatives. The intent of the project is to identify and provide recommendations for best of breed practices for maintaining a proficient workforce while preserving the integrity of the Army civilian Program Manager profession. While identification and recommendations for best of breed practices have been stated, the availability of qualification initiatives is either limited or emerging. As such, the researchers have identified future areas for further study. DAWIA addresses career path requirements in Title 10, United States Code 1723 by stating that the Secretary of Defense acting through the Under Secretary of Defense for Acquisition, Technology and Logistics, shall establish require-

ments for the completion of course work and related on-the-job training and demonstration of qualifications in the critical acquisition-related duties and tasks of the career path. Workforce demographics are changing. The intent of the project is to examine current credentialing processes in place to maintain a proficient workforce and preserve the integrity of the profession. Prior research regarding the effectiveness of DAWIA exists. This project will leverage this available body of knowledge and will compare it to existing processes to identify more efficient mechanisms/certifications for qualifying civilian Army acquisition Program Managers. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37688

Keywords: Defense Acquisition Workforce Improvement Act, DAWIA, acquisition workforce

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MASTER OF SCIENCE
IN
REMOTE SENSING INTELLIGENCE

LIDAR POINT CLOUD AND STEREO IMAGE POINT CLOUD FUSION

Paul Basgall–DoD Civilian, National Geospatial-Intelligence Agency
Master of Science in Remote Sensing Intelligence
Advisor: Fred Kruse, Department of Physics
Second Reader: R. C. Olsen, Department of Physics

The advent of light detection and ranging (LiDAR) point cloud collection has significantly improved the ability to model the world in precise, fine, three-dimensional details. The objective of this research was to demonstrate accurate, foundation methods for fusing LiDAR data and photogrammetric imagery and their potential for change detection. The scope of the project was to investigate optical image to LiDAR registration methods, focusing on several dissimilar image types, including optical bar camera (OBC), high resolution aerial frame, and WorldView 1 satellite with varying LiDAR point densities. An innovative optical image to LiDAR data registration process was established. This approach was demonstrated for one image type using the rational polynomial coefficients representation of the panoramic math model improving accuracy from 1.9m to 0.5m root mean square error. Comparison of stereo imagery point cloud data to the LiDAR point cloud using a 90% confidence interval highlighted changes that included small scale (<50cm), sensor dependent change and large scale, new home construction change. This research also proposed a fused LiDAR and stereo image base layer as the foundation for further LiDAR/image fusion. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37584

Keywords: light detection and ranging, LiDAR, photogrammetry, fusion, accuracy

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MASTER OF SCIENCE IN SPACE SYSTEMS OPERATIONS

THE FUTURE OF HUMAN SPACE EXPLORATION: TOWARD COOPERATION OR COMPETITION?

Priscilla Adams–Captain, United States Air Force
Master of Science in Space Systems Operations
Advisor: James Moltz, Department of National Security Affairs
Second Reader: Daniel Bursch, Space Systems Academic Group

Over the past 52 years, the world has progressed from the first man in space, to landing on the moon, to permanent human presence on manned space stations. Mankind is now poised to explore even farther. The purpose of this thesis is to analyze whether international cooperation or competition is more in the United States' interest from the perspective of political, technological, and cost-effectiveness criteria for returning humans to the moon, Mars or an asteroid and establishing a permanent presence. The 1960s space race between the United States and USSR and current cooperation on the International Space Station will provide a historical basis for comparison. Countries with major space programs will be reviewed for possible partnerships in future space endeavors. This thesis concludes that the future and next steps for human spaceflight with international partners will need to begin as a coordinated and interdependent effort at the onset with the goal of habitation on the moon. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37577

Keywords: human spaceflight, international cooperation, competition, 1960s space race, USSR, International Space Station, ISS, NASA, Russia, China, Europe, European Space Agency, ESA, Japan, Japan Aerospace Exploration Agency, JAXA, India, Indian Space Research Organization, ISRO

REPLACEMENT CAPABILITY OPTIONS FOR THE UNITED STATES SPACE SHUTTLE

Matthew Buehler–Captain, United States Air Force
Master of Science in Space Systems Operations
Advisor: William Welch, Department of Information Sciences
Second Reader: Steven Clarke

After having invested millions of dollars into the International Space Station (ISS) and retiring the Space Shuttle, NASA and the United States are in the rare position of not having an operational human space lift program to reach the ISS or any location in space. This is truly an unusual time period in the history of NASA manned spaceflight. This thesis addresses the human spaceflight, Up Mass (launch a payload into space), and Down Mass (return payload from space) capabilities of the U.S. Space Shuttle and assesses options to regain these capabilities now that the Space Shuttle is retired. The research in this thesis was done with unclassified and public-domain information that was used to evaluate and propose options for mitigating the capability gaps left by the end of the U.S. Space Shuttle program. No current or planned system can fulfill all the capabilities that the Space Shuttle was able to provide. However, there are current/future domestic and foreign systems that can or will address these capabilities individually. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37590

Keywords: Space Shuttle, commercial crew development, CCDev, commercial crew integrated capability, CCiCap, Commercial Crew Program, CCP, Commercial Orbital Transportation Services, COTS

GLOBAL POSITIONING SYSTEM DISASTER NOTIFICATION MESSAGING SERVICE

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Master of Science in Space Systems Operations
Advisor: Daniel Bursch, Space Systems Academic Group
Second Reader: Alexander Bordetsky, Department of Information Sciences

The United States has offered free worldwide position, navigation, and timing (PNT) broadcast data through the Global Positioning System (GPS) since its 1993 initial operations capable declaration, and periodic modernization efforts have been made throughout its 20-year history. A planned modernized L5 safety of life GPS signal, combined with the current GPS-enabled device ubiquity, offers an unprecedented opportunity to embed and broadcast other non-PNT information into GPS signals and reach individuals on a global scale with information in new ways. Adequate additional bandwidth exists in the new L5 safety of life signal to embed notification information for worldwide natural and technological disasters and add a new communication medium for a possible global disaster notification system. This thesis explores the background, requirements, system design and U.S. policy of a disaster-notification enabled GPS L5 safety of life signal. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37592

Keywords: GPS, Disaster Notification Messaging Service, natural disaster, technological disaster, disaster, safety of life, L5, warning system

MODTRAN RADIANCE MODELING OF MULTI-ANGLE WORLDVIEW-2 IMAGERY

This thesis has been recognized as outstanding by its department.

Samuel Marshall–Commander, United States Navy
Master of Science in Space Systems Operations
Advisor: Richard Olsen, Department of Physics
Co-Advisor: Fred Kruse, Department of Physics

The WorldView-2 satellite, launched in 2010 by DigitalGlobe, provides researchers with the ability to collect high resolution, multi-angle, 8-band multispectral imagery. This offers a unique opportunity to investigate the reflectance properties including the bidirectional reflectance distribution function of surfaces detected from a space-based remote sensing platform. Eight images were collected over Rio de Janeiro on January 19, 2010, at approximately 1000 local time. Solar geometry during the collect remained constant while sensor geometry ranged from approximately 10 degrees off-nadir to 60 degrees off-nadir, fore and aft. To enhance understanding and provide comparison data with the multi-angle imagery data, radiance models were generated using the Moderate Resolution Atmospheric Transfer code. General models, using surface albedos ranging from 1% to 100%, and comparison models, using properties as close as possible to that found in the imagery, were built. Using data derived from all sources, variations were readily apparent that could be attributed to the multi-angle geometry of the collect, the wavelength of the light sensed and reflectance. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37669

Keywords: remote sensing, WorldView-2, multispectral, Moderate Resolution Atmospheric Transfer code, MODTRAN, MODTRAN Graphical User Interface Software Program, MODO, Environment for Visualizing Images Software Application, ENVI, BRDF, bidirectional reflectance distribution function, multi-angle, reflectance, radiance, Rio de Janeiro

EFFECT OF NONLINEARITIES ON ORBIT COVARIANCE PROPAGATION

Christopher McLeod–Captain, United States Air Force
Master of Science in Space Systems Operations
Advisor: Kyle Alfriend, Department of Mechanical and Aerospace Engineering
Second Reader: I. Michael Ross, Department of Mechanical and Aerospace Engineering

This thesis will examine the effect of nonlinearities on the propagation of orbit uncertainties in order to gain insight into the accurateness of the estimation of covariance with time. Many real-world applications rely on a first-order approximation of nonlinear equations of motion for propagation of orbit uncertainty. The nonlinear effects that are ignored during the linearization process can greatly influence the accuracy of the solution. A comparative analysis of linear and nonlinear orbit uncertainty propagation is presented in order to attempt to determine when linearized uncertainty becomes non-Gaussian. An examination of performance metrics is then accomplished to compare linearly propagated uncertainty to uncertainty propagated using a second-order approximation. An attempt is then made to develop a performance metric that determines when propagated uncertainty is no longer Gaussian. The results show that it is difficult to determine a clear method of defining when the linear approximated uncertainty is no longer Gaussian, but there are metrics that can be implemented given a user-defined threshold of performance. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37675

Keywords: space situational awareness, orbital mechanics, Non-Linear Covariance Propagation

DESIGN OF DISCRETE TIME RADIO RECEIVER FOR THE DEMODULATION OF POWER-SEPARATED CO-CHANNEL SATELLITE COMMUNICATION SIGNALS

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Master of Science in Space Systems Operations
Master of Science in Electrical Engineering
Advisor: Frank Kragh, Department of Electrical and Computer Engineering
Second Reader: Scott Matey, Space Systems Academic Group

This thesis has two purposes: (1) to document the design of a discrete-time radio receiver for the coherent detection of a QPSK signal in the presence of additive white Gaussian noise; and (2) further research into the performance of representative receivers in the successive demodulation of power-separated, co-channel satellite communications signals. Several commercial companies are offering satellite modulators and demodulators that allow frequency reuse over satellite communications links. There are two methods to demodulate these co-channel signals. The first method requires a priori knowledge of one of the two signals linearly superimposed in the satellite downlink. With this knowledge, the known signal is cancelled using subtraction to reveal the unknown co-channel signal. A second method of recovering both signals is possible if adequate power separation of the two signals allows recovery of the strong signal. After recovery of the strong signal, the data can be re-modulated and then cancelled from the composite signal to reveal the weak signal. This method has the advantage of not requiring a priori information which widens the applications for layered modulation techniques to simplex, broadcast, and multi-cast network architectures. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37719

Keywords: satellite communications, frequency reuse, layered modulation, discrete-time radio design, software defined radio

CONTENT-AWARE ADAPTIVE COMPRESSION OF SATELLITE IMAGERY USING ARTIFICIAL VISION

This thesis has been recognized as outstanding by its department.

Jeffrey Wilcox–Lieutenant, United States Navy
Master of Science in Space Systems Operations
Advisor: Mathias Kolsch, Department of Computer Science
Second Reader: Richard Olsen, Department of Physics

This thesis aims to improve image throughput from satellite to Earth by using artificial vision to perform data compression before the downlink. Onboard analysis for selective imagery compression (OASIC) is a hybrid compression algorithm designed for oceanic imagery, incorporating both lossless and lossy compression methods to achieve a high compression ratio with minimal noise on vessels of interest. This is achieved by separating the vessels from the surrounding ocean and storing them with high fidelity while compressing the remainder of the image with low fidelity. The performance of OASIC is examined on full resolution panchromatic satellite images and compared to both lossless and lossy JPEG2000 compressed images. In nearly all configurations tested, OASIC outperforms JPEG2000, achieving an average fifteenfold improvement in compression ratios while maintaining a nearly lossless fidelity for the vessels within the OASIC compressed images. This content-sensitive compression algorithm can potentially enable the transmission of higher spatial resolution images, with more spectral bands, and at higher download speeds from space. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37744

Keywords: lossless image compression, lossy image compression, ship detection, support vector machine, discrete wavelet transform, artificial vision, satellite imagery

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

The following theses and capstone project reports were produced by residential or distance-learning students in the systems-engineering curriculum. The degrees awarded include Masters of Science in Systems Engineering and Systems Engineering Management.

MISSILE DEFENSE IN THE 21ST CENTURY ACQUISITION ENVIRONMENT: EXPLORING A BMD-CAPABLE LCS MISSION PACKAGE

Cayle Bradley–Civilian, Department of the Navy
Darren Ly–Civilian, Department of the Navy
Dennis Gamban–Civilian, Northrop Grumman Marine Systems
Hermanzo Moreno–Civilian, Department of the Navy
Matthew Podawiltz–Civilian, Northrop Grumman Marine Systems
Adam Wilk–Civilian, Lockheed Martin Corporation
Master of Science in Systems Engineering
Advisor: John Green, Department of Systems Engineering
Co-Advisor: Paul Shebalin, Department of Systems Engineering

In the aftermath of the Cold War, proliferation of late-20th-century Soviet and NATO offensive weaponry has provided many countries and groups around the globe with the ability to challenge the defensive infrastructure of neighboring states. With the collapse of the Soviet Union, the struggle between two great superpowers to gain and maintain access to regions of strategic interest has been eclipsed by the emergence of new threats—corrupt regimes, warlords, and terrorists who now have the capability to attack civilian populations, destabilize regional governments, and threaten U.S. and allied strategic interests. Of particular concern are the threats presented by aggressor short- and medium-range ballistic missiles. These weapons, capable of carrying weaponized chemical or biological payloads, are small, mobile, and difficult to track. Aegis, the premiere sea-based ballistic missile defense (BMD) system of the U.S. Navy, is a high-demand, cost-limited resource that cannot be mobilized to defend all potential target zones. A smaller, more mobile solution is necessary to afford foreign U.S. interests adequate protection. This paper details a systems engineering approach to assess the emergent ballistic missile threat, synthesize solution options to meet littoral region capability needs, and conduct comparative analyses to downselect a conceptual BMD system that meets stakeholder needs. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37707

Keywords: ballistic missile defense, BMD, littoral combat ship, systems engineering, raid annihilation, probability of kill, radar, fire control

CAPABILITY DELIVERY WITH FOG OF EMERGENCE

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Advisor: Gary Langford, Department of Systems Engineering
Co-Advisor: Man-Tak Shing, Department of Computer Science
Second Reader: Robert Harney, Department of Systems Engineering

A proposed capability delivery ontology with fog of emergence provides a language construct to relate how the processes and parts of a notional capability delivery system incrementally produce and refine a capability through well-known life cycle phases. The natural propensity for capability delivery organizations to perform these life cycle activities using intended missions and requirements instead of as-deployed missions and emergent traits give rise to the fog of emergence that obscures the organizations' perception of the capability as it is taken through its life cycle. Through capability delivery ontology, the embedded fog of emergence is used as a prism to separate the white light of capability performance into its constituent colors of as needed, as-planned, as-known, and as-deployed perceived by the capability delivery organizations. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37601

Keywords: capability delivery system, emergence, capability delivery ontology, fog of emergence

SMALL TACTICAL UNMANNED AERIAL SYSTEM (STUAS) RAPID INTEGRATION AND FIELDING PROCESS (RAIN)

Christopher Ironhill–Civilian, Department of the Navy
Bryan Otis–Civilian, Department of the Navy
Frederick Lancaster–Civilian, Department of the Navy
Angel Perez–Civilian, Department of the Navy
Diana Ly–Civilian, Department of the Navy
Nam Tran–Civilian, Department of the Navy
Master of Science in Systems Engineering
Advisor: Rama Gehris, Department of Systems Engineering
Co-Advisor: Bonnie Young, Department of Systems Engineering

The Department of the Navy (DoN) maintains an inventory of small tactical unmanned aircraft systems. These systems are designed for payload modularity to support user selection of multiple mission configurations in order to meet any unique mission need. Numerous mission ready payloads have been developed for each system and only need to be integrated in order to become part of the fielded unmanned aerial system (UAS) configuration. Unfortunately, the DoN does not have a method that maintains sufficient systems engineering (SE) discipline to rapidly integrate and field new mission configurations to the fleet in support of aggressive schedules and urgent user needs. The typical fielding time frame can range from 24 to 36 months instead of the desired 6 to 18 months. Furthermore, without a sufficient SE approach, risk to mission success is not well understood. This paper captures all applicable requirements for fielding a new capability onto an existing UAS, and, using an SE approach, outlines a process to rapidly integrate payloads into a DoN system. The process identified provides a comprehensive list of integration requirements; a cost, schedule, and performance trade-off analysis; technical risk associated with each tradeoff option; and recommendations for how to best support a rapid fielding timeline. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37705

Keywords: systems engineering, unmanned aerial vehicle, UAV, unmanned aerial system, UAS, rapid fielding, timeline reduction, modeling, simulation, cost, performance, schedule

TRAINING SYSTEM DEVICE CERTIFICATION AND QUALIFICATION PROCESS

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Master of Science in Systems Engineering Management
Advisor: Rudolph Darken, Department of Computer Science
Second Reader: Jeff Aparicio, Department of Systems Engineering/Operations Research

Training system devices are frequently used for aviation training to prepare students to fly aircraft. The use of training systems can be used to reduce the number of flight hours required for pilots and aircrew. The aviation training system device must be designed properly to ensure that necessary learning objectives are met. Certification is the last step in the test and evaluation process during the validation phase, within the systems engineering process, that ensures the system works as it was intended and meets the users need. Training system certification ensures the user that the training device can be used to properly meet certain learning objectives prior to flying. This thesis analyzes existing training system device certification processes and provides recommendations to the United States Navy, Naval Air Warfare Center Training Systems Division for improvemen
See full thesis text: https://calhoun.nps.edu/public/handle/10945/37624

Keywords: training, training system device, simulator, certification, qualification

USING MODEL BASED SYSTEMS ENGINEERING AND THE SYSTEMS MODELING LANGUAGE TO DEVELOP SPACE MISSION AREA ARCHITECTURES

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Master of Science in Systems Engineering Management
Advisor: Mark Rhoades, Department of Systems Engineering
Second Reader: Kristin Giammarco, Department of Systems Engineering

Model based systems engineering (MBSE) is explored as an alternative to the Department of Defense's (DoD) heavily document-driven processes for architecture development and acquisition management. MBSE can be employed to meet the standards set in the DoD acquisition framework. Data exchange specifications, such as the application protocol 233 (AP233), can be implemented to enable synergistic benefits to data analysis across the enterprise. Architecture development techniques, including the structured analysis and design technique and the systems modeling language (SysML), are introduced to aid in the development and assessment of space system mission area architectures, enabling rigorous mathematical analysis to support key programmatic decisions. A detailed example of the application of SysML, in conjunction with MBSE principles, is provided for the Overhead Persistent Infrared mission area, specifically the Space Based Infrared Surveillance System. A three-phase adoption approach is recommended. First, identify, list, and manage the configuration of all critical program models, processes, and tools used throughout the DoD. Second, mandate a data exchange specification, such as the International Organization for Standardization (10303 AP233) standard, across the DoD space acquisition community. Finally, further standardize the implementation of MBSE practices through implementation of SysML. Heuristics for developing system architecture are provided.
See full thesis text: https://calhoun.nps.edu/public/handle/10945/37644

Keywords: model based systems engineering, MBSE, systems modeling language, SySML, structured analysis and design technique, SADT, pplication Protocol 233, AP233, Department of Defense Architecture Framework, DoDAF, Space Mission Area System Architecture, MASA, Overhead Persistent Infrared, OPIR, Space Based Infrared Surveillance System, SBIRS, system architecture heuristics

A STUDY ON PREDICTIVE ANALYTICS APPLICATION TO SHIP MACHINERY MAINTENANCE

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Second Reader: Fotis Papoulias, Department of Systems Engineering

Engine failures on ships are expensive and affect operational readiness critically due to long turn-around times for maintenance. Prior to the engine failures, there are signs of engine characteristic changes—for example, exhaust gas temperature (EGT) —to indicate that the engine is acting abnormally. This is used as a precursor for the modeling of failures. There is a threshold limit of 520 degrees Celsius for the EGT prior to the need for human intervention. With this knowledge, the use of time series forecasting technique to predict the crossing over of threshold is appropriate to model the EGT as a function of its operating running hours and load. This allows maintenance to be scheduled just in time. When there is a departure of result from the predictive model, cumulative sum (CUSUM) control charts can then be used to monitor the change early before an actual problem arises. This paper discusses and demonstrates the proof of principle for one engine and a particular operating profile of a commercial vessel with the use of predictive analytics. The realization with time series forecasting coupled with CUSUM control chart allows this approach to be extended to other attributes beyond EGT. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37659

Keywords: predictive, precursor, machinery maintenance, failures

INCORPORATING LEARNING THEORY INTO EXISTING SYSTEMS ENGINEERING MODELS

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Co-Advisor: Douglas Nelson, Department of Systems Engineering

Systems engineering and learning theories are two major disciplines that involve preparing people to solve problems. While learning theories and their elements are apparent in the field of systems engineering, limited work has been performed on the interactions and relationship between these two disciplines. This thesis aims to establish and discuss a relationship between systems engineering and learning theories over the key phases of a systems life cycle. This thesis discusses how organizations can use the information attained from the collaborative approach between systems engineering and learning theories to leverage practitioners' work quality, capability, and decisions to help justify and improve key systems parameters. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37661

Keywords: systems engineering, learning theories

THE RISE OF ROBOTS AND THE IMPLICATIONS FOR MILITARY ORGANIZATIONS

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Master of Science in Systems Engineering
Advisor: Gary Langford, Department of Systems Engineering
Co-Advisor: Douglas Nelson, Department of Systems Engineering

This thesis explores the reasons for the inevitability of the extensive use of robots in military organizations, projects the adoption timeframe for robots in military organizations, proposes how robots might evolve, assesses the impact of robots on military organizations, and suggests the way forward for military organizations to facilitate the adoption of robots. Macro environmental trends suggest that the use of robots is the way forward for military organizations. The thesis projects that the adoption rate of robots will pick up from this point

forward and will reach market saturation in a matter of decades. The use of robots has physical, functional, and behavioral implications for military organizations, and their increasing numbers will affect how militaries are organized and alter the existing organizational processes in the long term. Military organizations will benefit from a better understanding of the impact of robots and the resulting challenges. Taking the necessary steps to mitigate the challenges and facilitate the evolutionary transition for the military organizations will allow these organizations to reap the benefits of robots and to operate effectively in the changing macro environment. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37662

Keywords: robots, drones, bots, unmanned systems, unmanned aerial vehicle, unmanned ground vehicle, unmanned surface vehicle, unmanned underwater vehicle, exoskeleton, free robots, tethered robots, autonomous, artificial intelligence

INFORMATION ASSURANCE AS A SYSTEM OF SYSTEMS IN THE SUBMARINE FORCE

Mark Morgan–Lieutenant, United States Navy
Master of Science in Systems Engineering Management
Advisor: Rex Buddenberg, Department of Information Sciences
Second Reader: Walter Owen, Department of Systems Engineering

There are significant gaps in the United States Navy Submarine Forces ability to integrate and manage information assurance (IA) requirements, information technology (IT) manpower, end-to-end security, IT equipment, IT training, and applicable documentation that meet the intent of the Design for Undersea Submarine Warfare initiative promulgated in July 2011. Furthermore, the Submarine Force lacks common criteria for IA integration as a system of systems. IT operators and system administrators must understand the concept of end-to-end security. Senior leadership should understand the end-to-end security concept so as to understand the cause and effect on overall ship mission and vulnerabilities. Organizational governance must raise the level of awareness as to network security protection. Training, personnel, and equipment, should connect with ethics and security practices for total end-to-end security. A paradigm shift in watchstanding must take place. Information technician submarine (ITS) duties are no longer a collateral duty. Submarine communications division and ITS division merging has the potential to solve the manning and watchstanding challenges. Senior enlisted leadership and senior communications officer leadership should take the lead on this merger, with command and control element support. The military procurement system is more oriented on acquiring platforms, not cross-platform sections. A more cohesive interface between the TYCOMS and the acquisition corps is needed. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37682

Keywords: information assurance, IA, New Design for Undersea Warfare, system of systems, end-to-end security, information assurance boundaries, information technician submarines, ITS, risk assessment, CYBER-1, Limited Duty Officer

LINKING COMBAT SYSTEMS CAPABILITIES AND SHIP DESIGN THROUGH MODELING AND COMPUTER SIMULATION

Christopher Pisani–Lieutenant, United States Navy
Master of Science in Systems Engineering
Advisor: Eugene Paulo, Department of Systems Engineering
Second Reader: Paul Beery, Department of Systems Engineering

When designing combat vessels, the traditional approach has been to configure weapons and other operational systems around the hull. Such thinking may have been rooted in the idea that hull design is the highest priority, since it can translate into a speedier and more seaworthy vessel, thereby allowing the vessel to reach its destination and complete its mission on a timelier basis. The traditional approach, however, has its shortcomings; once the ship is built, modifications to meet changing operational requirements can be costly and difficult to imple-

ment. Ship designers have long sought a methodology to identify such shortcomings by linking mission requirements with naval requirements in the early stages of ship design. The ongoing challenge has been to devise a synthesizing and modeling tool that enables designers to assess the trade-offs that may occur as design modifications are proposed. The Naval Postgraduate School has taken on this challenge through its design concept using model-based systems engineering (MBSE). This thesis considers how MBSE might extend its use of simulation and modeling to better link architectural ship designs to combat system requirements. This thesis considers such linking and identifies a synthesizing tool that may facilitate the synthesizing and modeling process. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37695

Keywords: offshore patrol vessel, model-based systems engineering, MBSE, ship design process, naval surface combatant, synthesis mode

SYSTEMS ENGINEERING AND PROJECT MANAGEMENT FOR PRODUCT DEVELOPMENT: OPTIMIZING THEIR WORKING INTERFACES

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This work discusses common issues that occur from the inadequate integration of systems engineering into the project management process. In so doing, this work is shaped by the following questions: What are the most common conflicts between program management and systems engineering during product development? Where in the product development cycle do conflicts occur? How can the conflicts be mitigated? This work identified three main conflicts within the product development process of the four case studies: the Hubble telescope, the Mars Polar Lander, the Demonstration of Autonomous Rendezvous Technology Program, and the Constellation program. The three main problems are insufficient systems engineering in the product development process, insufficient budget and tight schedule, and inadequate risk management. These three issues eventually led to the mishaps and failures of the case studies examined in this thesis. This work proposes that, in order to mitigate conflicts in the integration of project management and systems engineering, systems engineers and project management should be able to have a common language, understand each other's objectives, and understand how these objectives benefit both the product and the project. Therefore, its recommendations are that systems engineers be trained in project management and project managers be trained in systems engineering and that this training should include risk management. In this case, risk management is the common language between systems engineering and project management. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37709

Keywords: systems engineering, project management, product development, risk management, risk analysis, systems integration, systems interfaces

METHODOLOGY TO IMPROVE AVIATION SECURITY WITH TERRORISTS USING AIRCRAFT AS A WEAPON

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The aviation industry is a large network of agglomerated systems that connects people and places. Since the 9/11 attacks, aviation security in the United States has undergone tremendous changes and improvements. Nonetheless, threat detection mechanisms remain imperfect as seen from hijacking attempts by passengers who have gone undetected via security. Alternate ways of thinking and looking at security were explored through a system

perspective. The focus was on a passenger security system with the intention of identifying potential areas of improvement for aviation security with terrorists using aircraft as a weapon. A supply chain approach was taken as the model to move and deliver people as goods through security checks to the aircrafts. Together with this approach, the concept of risks, uncertainties and the associated risk assessment of potentially defective goods were examined. A systems engineering process was used. Through systematic analysis scrutinizing interactions between airport objects and passengers (as objects), this thesis pinpoints possible gaps and thereby identifies approaches or means to safeguard and counter these risks. Analysis included the exploration of the trade space between different entities within the system and the interactions between objects, functions, processes, and its associated results. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37716

Keywords: passenger security system, aviation security, supply chain, risk index

A SYSTEMS APPROACH TO FINDING COST-EFFECTIVE ALTERNATIVES TO EUROPEAN BALLISTIC MISSILE DEFENSE

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Increasing political tensions between nations, coupled with advancements in technology, have resulted in the need for a ballistic missile defense (BMD) system—specifically, in the European theater, where ally nations are particularly vulnerable. This report focuses on defending Turkey with a solution that could be fielded by FY18. It includes the following mature technologies: Patriot Advanced Capability-3, Terminal High Altitude Area Defense (THAAD), Army Navy/Transportable Radar Surveillance, and BMD capable Aegis ships. Compiling the anticipated needs of stakeholders and identifying the most prominent threat focuses the research efforts. To identify any functional gaps the analysis uses functional decomposition and flow block diagrams before entering modeling and simulation. By focusing on footprint area defense and testing multiple scenarios, performance gaps are revealed; generic parameters keep this report unclassified. The results from the simulations led to several alternatives. Alternative A places two BMD Aegis capable ships along the northern and southern coasts of Turkey; Alternative B specifies several THAAD batteries in various locations; and Alternative C dictates an Aegis Ashore in the eastern region of the country. Alternative C was determined to be the best choice, taking into account modeled performance and total life-cycle cost. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37706

Keywords: ballistic missile defense, European phased adaptive approach, EPAA, Aegis ships, Aegis Ashore, Patriot Advanced Capability 3, PAC-3, System Toolkit, STK, BMD, Army Navy/Transportable Radar Surveillance, AN/TPY-2, Terminal High Altitude Area Defense, THAAD, LCC , boost, midcourse, terminal, Shahab, Sejil, Turkey

DETERMINING INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (ISR) SYSTEM EFFECTIVENESS, AND INTEGRATION AS PART OF FORCE PROTECTION AND SYSTEM SURVIVABILITY

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Situation awareness plays a critical role in all battlefields. It monitors activities and provides essential information about the battle. It is an operational requirement, high in demand, for the forces to fight the battle smartly and accomplishing the objectives set with minimal casualties. Situation awareness enhances survivability of the fighting forces by avoiding adversary detection and acquisition, achieved via the deployment of a variety of sensors that are part of an effective and integrated intelligence, surveillance and reconnaissance (ISR) system network. This thesis analyzes the impact of ISR system effectiveness and integration on unit survivability in the context of a combined arms unit. The study was approached using the Nearly Orthogonal Latin Hypercube to generate design points for simulation study. Map Aware Non-uniform Automata was used to simulate the behavior of the units in the combined arms unit. During simulation, the parameters are varied to create a changing situation picture, as perceived by the troops. This determines the impact on survivability, by measuring the force exchange ratio between the RED and BLUE force, once the simulation is completed. The sensor capabilities and level of integration between the ISR sensors in the combined arms unit are analyzed based on the simulation results. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37721

Keywords: intelligence, surveillance and reconnaissance, ISR, combined arms unit, Map Aware Non-uniform Automata, MANA, MBSE, systems engineering, Latin Hypercube, Orthogonal, space-filling, simulation, situational awareness, situation awareness, unit survivability, force exchange ratio, integration

CLOSING THE GAP BETWEEN RESEARCH AND FIELD APPLICATIONS FOR MULTI-UAV COOPERATIVE MISSIONS

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The ability to fly multiple unmanned aerial vehicles (UAVs) in collaboration has the potential to expand the scope of feasible UAV missions and could become the backbone of future UAV missions. However, despite having garnered significant research interest, there is no indication that systems supporting collaborative operation of multiple UAVs are close to achieving field deployment. The challenge of successfully deploying a quality system is inherently complex, and systems engineering offers an approach to handle the complexities. Effective application of systems engineering requires both knowledge breadth and depth. This thesis presents the results of a consolidation of information intended to support the conduct of systems engineering activities and describes an experiment to ascertain the sensitivities of some key operational parameters (e.g., acquisition, pointing, and tracking). The experiment was conducted using automatic dependent surveillance-broadcast and visual tracking equipment employing state-of-the-art technology to understand the operating challenges and requirements of using this equipment to provide situational awareness for a UAV pilot. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37730

Keywords: system engineering, unmanned aerial vehicle, UAV, UAVs, unmanned aerial system, UAS, multi-UAV, collaborative, cooperation, automatic dependent surveillance-broadcast, ADS-B, situational awareness,

mission, concept of operations, CONOP, video tracking, ISR, urban, collision avoidance, automation, interoperability, swarm

A MODEL FOR EFFECTIVE SYSTEMS ENGINEERING WORKFORCE DEVELOPMENT AT SPACE AND NAVAL WARFARE SYSTEMS CENTER (SSC) ATLANTIC

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This thesis describes a methodology used to develop a systems engineering (SE) competency framework for the Space and Naval Warfare Systems Center (SSC) Atlantica Department of Navy organization, whose vision statement is to make IT count for the warfighter and the nation. This methodology defines the role of systems engineers at SSC Atlantic; establishes prioritized SE competency areas; identifies associated knowledge, skills and abilities (KSAs); identifies optimal workforce development methods for each KSA; and addresses how to assess systems engineers against a competency development model. The results of this analysis show that systems engineers require many of the same KSAs as other members of the engineering workforce but also require unique KSAs focused on customer mission/capability areas, technology areas, SE processes/activities and leadership skills. Developmental methods for systems engineers to obtain these KSAs range from informal on-the-job training to professional certifications and degrees. The methodology established in this thesis can be used by other organizations to develop and employ their own competency framework in practically any discipline. The SE competency framework defined in this thesis can be leveraged/tailored by other SE organizations in order to establish developmental roadmaps for improving the KSAs of their workforce. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37738

Keywords: systems engineering, competency model, competency framework, competency development model, SPAWAR, space and naval warfare command, Space and Naval Warfare Systems Center, SSC Atlantic, education, training

BUILDING A LOCAL SPACE SITUATIONAL AWARENESS (SSA) ARCHITECTURE USING HOSTED PAYLOADS

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From a military standpoint, space-based capabilities and the need to know what is happening in space, or space situational awareness (SSA), have become invaluable. Current SSA capabilities are expensive and are limited in scope. Hosted payloads, however, provide a unique method to provide SSA in a relatively inexpensive manner. This thesis explores the development of an architecture for SSA using hosted payloads. For this thesis, research was conducted on existing systems. NASA and Air Force programs were reviewed to gain an understanding of hosted payloads, and a set of generic high-level requirements were developed for a hosted payload. These requirements will meet the needs of a hosted SSA payload that can enable a larger SSA architecture using hosted payloads. Once the requirements were developed, modeling and simulation using Satellite Tool Kit (STK) were employed to develop an optimal SSA system using hosted payloads. Finally, once the architecture was defined, an Operational View 1 was developed to provide a graphical representation of the architecture. See full thesis text: https://calhoun.nps.edu/public/handle/10945/37749

Keywords: hosted payloads, space situational awareness, SSA, space

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